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ABSTRACT

Written for Health Systems Agency staff or board members who must analyze and evaluate a certificate of need (CON) application for a medical information system from a hospital, as well as for hospital executives who must prepare and submit such applications, this guidebook is intended to foster better decision-making in the acquisition of medical information systems consistent with the criteria established in the National Health Planning and Resources Development Act of 1974 (Public Law 93-641). Chapters describe (1) health planning review requirements; (2) current CON application deficiencies; (3) CON assessment criteria; (4) assessment of system alternatives; (5) assessment of acquisition alternatives; (6) hospital development plan and system objectives; (7) resource requirements; (8) financial feasibility and economic impact; and (9) treatment of systems used for research purposes. A bibliography lists more than 90 sources. (FM)

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Health Planning Review of Medical Information Systems

Melville H. Hodge

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Foreword

Expenditures by hospitals in the United States for medical information systems and computer controlled equipment have been projected to rise over the next decade to a level of $2 billion per year. The public interest demands that this investment result in benefits that justify its cost. Rapid advances in computer technology offer exciting potential to significantly impact on management and information processing which now accounts for as much as *one third of the cost of inpatient care*. Yet, the complexity of this technology and the lack of relevant training in this field of hospital management have led too often to disappointing experiences and little return on the investment of health care dollars. Likewise, health planners who are mandated to carry out Certificate-of-Need review for hospital capital expenditures are faced with the same difficulties—lack of specialized experience in a complex and rapidly advancing science. This document does not evaluate specific commercial information systems. Its intent is to provide a mechanism for asking relevant and constructive questions pertaining to the assessment of any system. It attempts not only to provide a tool for evaluating hospital proposals, but also to encourage the health planner and hospital to work together in developing a sound medical information system plan.

Gerald Rosenthal, Ph.D.
Director

May 1981

Preface

Technology has invaded health care in our time. Today, a hospital without machines would seem quaint. Yet, all too often technology has contributed higher costs and only questionable benefits. To that end, health planning policy has increasingly extended its focus beyond capacity to technology.

Most hospital technology is clinically oriented-CAT scanners, automated chemistry analysis, monitoring systems, dialysis machines . . . An important subset of hospital technology, however, is the application of modern computer-communication technology to the operation of the hospital. Borrowing the economic arguments of Martin Feldstein, this author has argued elsewhere (*Medical Information System*, Aspen, 1977) that medical information systems are, or at least can be, an example of cost lowering technology rather than simply one more cause of escalating hospital bills.

The origins of this technology in hospitals can be traced to the early sixties. Introduction of comprehensive, sophisticated systems did not occur, however, until the following decade. The National Center for Health Services Research initiated its support of landmark evaluation research by Battelle at El Camino Hospital in 1971, leading to a series of reports culminating in 1979. While the incentive structure in which hospitals operate complicated interpretation, it is clear that this research demonstrated both patient care gains and productivity gains.

The Battelle studies were directed at a sophisticated physician/nurse oriented comprehensive system. Meanwhile, other hospitals were installing a variety of less sophisticated hospital-wide systems and also a number of specialized departmental systems (business office, laboratory, etc.). Approaches to these systems ranged from "do-it-yourself" development starting with a computer and a programming manual to subscribing to systems operated from centralized computers supporting hundreds of hospitals. Little or no independent evaluation has been done on most of these systems and approaches.

Faced with this plethora of computer technology, hospital executives and health planners are placed in an uncomfortable decision making role. Under the National Health Planning and Resources Development Act of 1974 (Public Law 93-641), formal review and approval by health systems agencies and state health planning and development agencies are mandated.

Thus, the purpose of the work reported here is to synthesize the research and experience of the last two decades into a useful form for use by non-technically trained people who also lack the time or the motivation to independently research this field, yet who must make *decisions* affecting the quality and cost of health care. Our goal has not been preparation of a formal review paper, but rather a readable, decision-maker oriented summary. The extent to which we have achieved our purpose will be seen only in the degree to which computer-communications contributes to better, cheaper hospital care in the future.

This work has been supported by Grant Number RO3 HS 03347 awarded by the National Center for Health Services Research. The author is particularly indebted to James Ullom of that organization for his counsel and assistance.

Special acknowledgment must also be given the many Health Systems Agencies who have generously shared their procedures and newsletters, and provided copies of relevant CON applications.

Hopefully, this book will prove sufficiently useful to them to repay them for their efforts.

Melville H. Hodge

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Summary

Purpose—The National Health Planning and Resources Development Act of 1974 (Public Law 93-641) created a review process for capital expenditures by hospitals. Beyond consideration of proposed capacity expansion, this review process, known as Certificate-of-Need (CON), extends also to the acquisition of hospital systems and equipment.

Under Grant R03 HS 03347-1 awarded by the National Center for Health Services Research, an inquiry has been made into the CON process as it relates to medical information systems and a book has been written for use by both hospital executives preparing CON applications and health planners reviewing such applications. The objective of this book is better decisionmaking in the acquisition of medical information systems by hospitals consistent with the criteria established in P.L. 93-641.

Background—Prior to the enactment of P.L. 93-641, capital expenditures by hospitals were subject to review under Section 1122 of the 1972 Amendment to the Social Security Act. Lack of adequate sanctions under the earlier law led to the creation of the CON process. P.L. 93-641 created a review process by regional Health Systems Agencies (HSA's) and State Health Planning and Development Agencies (SHPDA's). Under enabling regulations issued by HEW, review by these agencies is mandatory for acquisition of any medical information system with a capital cost in excess of $150,000 regardless of the method of acquisition (purchase, lease, rental, donation, etc.)

Six regulatory criteria are potentially relevant to medical information systems:

1. The relationship of the system to the long range development plan (if any) of the hospital.
2. The need that the hospital's patient population has for such services.
3. The availability of less costly or more effective alternatives.
4. The immediate and long-term financial feasibility of the proposal, as well as the probable impact on the costs and charges for providing health services by the hospital.
5. The availability of resources (including health manpower, management personnel, and funds for capital and operating needs) and the availability of alternative uses for such resources.
6. The special needs and circumstances of biomedical and behavioral research p.ojects which are designed to meet a national need.

Given this regulatory requirement, a need existed to review how effectively the review process was functioning for acquisition of medical information systems and to provide guidelines to decision makers to improve the process.

Findings—All 204 HSA's identified in the September 1978 directory were contacted. 116 HSA's responded, enabling 74 medical information systems to be identified. The following findings were made:

1. About 10 medical information system CON applications are made each month throughout the United States.
2. Applications range from $40,000 to $7,789,000 with a mean of $1,000,000 and median of $689,000.
3. It is likely that a significant number of systems are acquired by hospitals without going through the CON process.

This work has been supported by Grant No. R03 HS-03347 awarded by the National Center for Health Services Research.

4. Actual expenditures for medical information systems by U.S. hospitals may be as high as $200,000,000 per year.
5. No instance of disapproval was found, raising some question as to the rigor of review.
6. Inappropriate data were typically submitted thereby rendering effective review impossible.
7. Non-hardware costs were often not considered.
8. Hospital information system development plans were typically lacking.
9. Relevant alternatives were often not considered.
10. Hospital line management involvement seemed often lacking.
11. Risks were infrequently assessed.
12. Financial analysis methodology was frequently inappropriate.
13. Specious economic claims were sometimes made.

Guidebook—Given the deficiencies reflected in the findings, a guidebook was written for use by hospital executives and HSA/SHPDA reviewers. Since each review organization has considerable latitude in establishing review forms, procedures, etc., the guidebook was prepared to deal with issues of substance rather than form. Emphasis has been placed on cooperation between the review agencies and hospitals to achieve the common purpose of acquiring only those medical information systems which will serve the public interest as defined by legislative and regulatory criteria. 5

The methodology used in preparing the guidebook was to synthesize existing research and experience. Emphasis was placed on preparing a highly readable document for non-technically trained personnel rather than a formal review paper.

The guidebook reflects the author's view that medical information systems represent a major opportunity to improve hospital productivity and effectiveness, provided that their acquisition is carried out as a rational process with careful consideration of the economic consequences. Despite specific deficiencies presently noted in this process, there is no reason to believe this optimism is misplaced.

Overview

CHAPTER 1

Introduction

This guidebook is written for two groups of people—Health Systems Agency (HSA) staff or board members who must analyze and evaluate a Certificate-of-Need (CON) application for a medical information system from a hospital, and hospital executives who must prepare and submit such applications. The emphasis is on substance rather than form. Each HSA establishes its own format and procedural requirements. There is little purpose to be secured in attempting to present the varied requirements of the 204 HSA's when the reader is interested in those of only one. Yet, the requirements derived from the National Health Planning and Research Development Act of 1974, Public Law 93-641, are common to all.

With the guidebook and the instructions from the cognizant HSA, the hospital executive should be able to do an effective job of preparing a CON for a medical information system and the HSA reviewer should be able to do an equally effective job of evaluating the proposed system application. The goal, however, is more than documentation and procedure; it is good decision making. The documentation and review procedure should simply record the fundamentals of the decision-making process. It should never be viewed as an end to itself. Unfortunately, review of medical information system CON's suggests that the latter is too often the case. Voluminous applications consisting of largely irrelevant data which are silent on important and even critical issues are commonplace.

Medical information systems

Chapter 5 will categorize and define systems more precisely. For now, *medical information system* may be defined to mean any computer based information system used in hospitals for recording, storing, transmitting, or retrieving information. Synonyms include hospital information system, data acquisition system, hospital computer system, etc. While it stretches the normal meaning of *medical information system* somewhat, individual departmental systems such as business office systems and laboratory information systems will also be covered.

Some Assumptions

The intended users of this guidebook are unlikely to have specialized experience with its subject. They are also assumed to lack training in computer science or programming. Realistically, they can devote only a limited amount of time to the subject at hand. The HSA member must review applications concerning every aspect of health care delivery. He or she may encounter a medical information system CON once or twice a year. Similarly, the hospital executive is in the business of running a hospital.

These assumptions require directing attention to fundamentals, and to do so at a non-technical level. This limitation will not, however, cause us to compromise the quality of decision making. Indeed, it is important—even essential—that the technical nature of medical information systems not result in their total delegation to computer experts. Certainly specialized expertise is required, but the central issue is how this technology impacts the economic delivery of hospital-based health care, something that the hospital executive must count among his or her fundamental responsibilities.

This limitation will mean, however, that the interested reader will not find a comprehensive exposition about medical information systems here, particularly at a detailed level. The reader may find the author's book, *Medical Information Systems* (Aspen Systems, Germantown, Maryland, 1977),

which includes rather extensive references to the literature, more useful for that purpose.

Another set of assumptions are those about the potential merits of medical information systems. The author believes that both experience and research have amply demonstrated that this technology can have a favorable impact on the quality and cost of hospital-based health care delivery. Indeed, it represents a major resource for improving productivity and for controlling labor costs, the major element in the continued inflation of hospital costs.

This inflation has been and continues to be so extreme that the author's bias tends to go beyond the requirements of the legislation and regulations under consideration here to the belief that medical information systems must not add to the cost of health care even if they provide other benefits such as quality enhancement. Hopefully, this bias has been minimized in this volume.

Importance

It is useful to explore the economic importance of medical information systems within the context of health planning. Are the dollar commitments high enough to justify the attention of health planners that preparation of this guidebook implies?

As part of its preparation, the author contacted each of the 204 HSA's identified in the September 1978 Directory. One-hundred and sixteen HSA's responded, enabling 74 medical information system projects to be identified. During the first half of 1979, project applications were received by these 116 HSA's at an average rate of six per month. By statistical inference, it is estimated that about ten medical information system CON applications per month are made throughout the United States. (It should be recalled that, since no applications are required from military, Veterans Administration, or Public Health Service hospitals, the number of medical information systems being installed is probably somewhat higher.)

Applications ranged in dollar magnitude from $40,000 to $7,789,000. The average size was $1,000,000 while the median was $689,000. Thus, it seems reasonable to estimate that Certificate-of-Need applications totalling $10 million are filed each month. As will be discussed further in Chapters 3 and 9, certain cost elements are frequently omitted. Further, there is indirect evidence that applications are not filed on all installations. In view of these factors, actual expenditures by United States hospitals for medical information systems may be as high as $200 million per year.

Despite this magnitude, our survey revealed *no* instance where a proposed medical information system project has been disapproved! Several conditional approvals were noted. Frequently, applications were treated as non-substantive as they did not affect bed or service capacity. Presumably, non-substantive applications receive a much more limited review.

We have suggested our belief in the merits of medical information systems; a large number of approved and implemented projects is consistent with that belief. In view of the deficiencies we will describe in Chapter 3, however, it is questionable whether an adequate review of proposed projects is being carried out by either hospitals or HSA's. Given the dollar magnitude of the associated investment, we believe that some attention to improving the quality of these reviews is warranted.

Guidebook organization

Chapter 2, *Health Planning Review Requirements*, outlines the legislative requirements under Public Laws 93-641 and 92-604 for review of capital acquisitions by hospitals and assesses the implementing regulations applicable to medical information systems. This chapter will be useful primarily to the hospital reader who lacks familiarity with this statutory/regulatory framework. The HSA member may undoubtedly skip it as its substance will already be well understood.

Chapter 3, *Current Certification-of-Need Application Deficiencies*, presents findings from a comprehensive review of medical information system CON's from throughout the United States. These deficiencies, along with the requirements identified in Chapter 2, create the implicit outline for the balance of this guidebook.

In Chapter 4, *A Certificate-of-Need Checklist*, the essential data elements for review are recorded. While these will overlap somewhat with the typically required data set, a medical information system inherently involves no expansion of either hospital beds or hospital services, the implicit premise on which most CON questionnaires are based.

Chapter 5 is entitled *Assessing System Alternatives*. This chapter will introduce a useful model for categorizing systems, discuss costs, risks and benefits, and identify system needs for each category.

Chapter 6, *Assessing Acquisition Alternatives*, will consider the various ways a given system can be acquired by a hospital—internal development, facilities management and externally provided services. Again, costs, risks, and benefits will be considered.

In Chapter 7, *Hospital Development Plan and System Objectives*, the basic considerations in long range planning of medical information systems for the hospital will be introduced. Emphasis will be placed on acquisition of a given system in the context of the ultimate automated information system derived for the institution including consideration of the impact of any future changes in the hospital's client population or services provided to that population.

Chapter 8, *Resource Requirements*, will identify the kinds of resources required for successful attainment of the hospital's medical information system objectives. Special emphasis will be placed on management and staff, including medical staff objectives.

Estimating the likely impact that system acquisition will have on cost performance of the hospital is perhaps the single most crucial step in intelligently assessing the acquisition of a prospective system. A framework for making such an estimate will be provided in Chapter 9, *Financial Feasibility and Economic Impact*. Particular stress will be placed on designing an effective benefit realization program and making concommitant commitment to benefit realization.

Finally, this book will conclude by examining the research aspects of medical information systems as required by the governing legislation in Chapter 10, *Special Requirements—Research*.

An appendix, *For Further Reading*, will guide the interested reader to additional publications of interest.

This guidebook draws heavily on the evaluation research that has thus far been carried out in the field, especially the extensive evaluation carried out at El Camino Hospital over the past eight years under sponsorship of the National Center for Health Services Research. The objective, however, is not a review paper, but rather a useful guidebook for decision making by people who have neither the time nor motivation to examine specific research designs and results. Therefore, this book endeavors to synthesize relevant research results with experience and judgment. Hopefully, the result will prove useful to the reader.

Introduction

On January 4, 1975, the 93rd Congress enacted Public Law 93-641, the "National Health Planning and Resources Development Act of 1974." The certificate-of-need requirements established by that law represent the primary control external to the hospital over acquisition of medical information systems. This chapter will describe this control mechanism. It will also take note of three other control mechanisms which may affect medical information systems. These are the capital expenditure review provisions authorized under Section 1122 of the Social Security Act enacted as Public Law 92-603 in 1972, the control over Federal funds for modernization, construction or conversion of medical facilities under P.L. 93-641 and finally periodic reviews of continuing "appropriateness" under that same law.

State role

Under P.L. 93-641, each state must develop a certificate-of-need program which must meet (but can also exceed) basic requirements established by Department of Health, Education, and Welfare ("HEW"). States may use any appropriate combination of new and existing legislation, administrative rules and executive orders to meet the requirement.

Because of the considerable flexibility given the states, and the continuing actions by states to come into compliance, it is essential to check requirements in effect at a given time in a given state. The perspective here must necessarily be limited to the minimum Federally mandated requirements.

Organization

Each state is required to establish a State Health Planning and Development Agency ("SHPDA") which will administer the state certificate-of-need program (and which will serve as the designated agency of the state for purposes of Section 1122 of the Social Security Act about which more will be said later).

The certificate-of-need is granted by the SHPDA. The SHPDA, however, must consider the recommendations of the Health Systems Agency ("HSA") which has previously reviewed the application. An HSA is established for each health planning region by agreement between a proposing organization and HEW after consultation with the affected state.

Thus, a certificate-of-need requires first, application to the HSA having cognizance over the region in which the applicant hospital is located, and after securing a favorable recommendation, making further application to the SHPDA.

Elements of a certificate-of-need program

The principal elements of a certificate-of-need program are scope, threshold criteria, due process and sanctions. In considering review of a hospital's application for a medical information system, those aspects of such a program which are not likely to be relevant to such an application will be ignored. Thus, the reader must exercise care in extending what is set forth here to other subjects where these ignored aspects might be relevant. The reader is also reminded that individual state requirements may be more stringent than the Federally mandated minimum requirements set forth here.

It is clear that acquisition of a medical information system requires a certificate-of-need if its capital cost exceeds $150,000. By "capital cost", is meant any expenditure which under generally accepted accounting principles is a capital expenditure.

Acquisition by lease, rental or even donation does not permit escape. The test is whether the acquisi-

tion would have required review had it been purchased, irrespective of the actual method of acquisition.

The $150,000 level (or such lower level that a state may establish) appears to be the only threshold of the five established by HEW which would "trigger" a requirement for a certificate-of-need for a medical information system. It is possible, of course, that such a system could be acquired by a series of capital expenditures, each under the threshold, but in combination exceeding the threshold. HEW has considered this possibility, but has specifically referred responsibility for dealing with it to each state.

HEW has established twelve criteria which must be included by both HSA's and SHPDA's among the considerations employed in their reviews. Six of the twelve are at least potentially relevant to medical information systems. These are:

1. The relationship of the system to the long range development plan (if any) of the hospital.
2. The need that the hospital's patient population has for such services.
3. The availability of less costly or more effective alternatives.
4. The immediate and long term financial feasibility of the proposal, as well as the probable impact on the costs and charges for providing health services by the hospital.
5. The availability of resources (including health manpower, management personnel, and funds for capital and operating needs) and the availability of alternative uses for such resources.
6. The special needs and circumstances of biomedical and behavioral research projects which are designed to meet a national need.

Much of the balance of this book will be devoted to relating these criteria to medical information systems.

P.L. 93-641 requires HEW to issue national guidelines which will include a wide range of goals and standards to which HSA's are expected to give appropriate consideration. Standards have already been published for general hospitals—occupancy rates, obstetrical services, neonatal special care units, pediatric inpatient services, open heart surgery, cardiac catheterization, radiation therapy, "CAT" scanners and end-stage renal disease. No standard has, however, been published for medical information systems and informed opinion within HEW suggests that no such standard will be published in the foreseeable future.

Thus, armed with the minimum considerations outlined above, it is necessary for each HSA and SHPDA to develop and adopt such criteria for medical information system review that they deem appropriate, following an open process involving a period for public comment.

There is no mandate (beyond common sense), requiring HSA's and SHPDA's to coordinate their criteria development. Applicant hospitals should, therefore, verify that their proposals will be reviewed against the same criteria at the local and state levels.

HSA's and SHPDA's are required to provide due process and publish application requirements, notification of reviews, notification of decisions, hearing opportunities and hearing appeal processes. Following determination that an application is complete and the required notification of interested parties and the public accomplished, the actual review is to be completed within 90 days. Because of variations among the states and the many HSA's, hospitals should seek specific guidance from their cognizant HSA on application procedures.

While it is up to each state to develop its own set of sanctions for failure to secure a required certificate-of-need, HEW must be satisfied that they are adequate to prevent such failure. HEW has suggested denial or revocation of the hospital's license, civil or criminal penalties, or injunctive relief. Withholding of reimbursement of expense for the capital expenditure in question is not considered an adequate sanction by HEW.

Section 1122 review

Lack of adequate sanctions in the previously inaugurated capital expenditure review provision of Section 1122 of the Social Security Act was a major factor leading to enactment of the certificate-of-need processes of P.L. 93-641 two years later. Sanctions under the 1972 law were limited to withholding of that portion of the hospital's reimbursement for patient care under Titles V, XVIII and XIX (Child Health, Medicare and Medicaid respectively) of the Social Security Act attributable to depreciation, interest and for proprietary hospitals, return on equity capital. For many hospitals, this sanction has proved ineffectual as a deterrent.

Under Section 1122, states can enter into a contractual relationship with HEW to undertake review

of capital expenditures on the basis of need. The subsequent enactment of P.L. 93-641 with its certificate-of-need requirement has not automatically ended the previous program but does require that the SHPDA administer the state's 1122 program if an agreement with HEW is in effect.

This apparent duplication has been perpetuated by a number of considerations. Some states have not yet passed legislation creating a certificate-of-need program acceptable to HEW. HEW has more control via contract over the specific provisions for 1122 review. Where a division exists within a state between the executive and legislative branches, the executive may be able to enter into the necessary 1122 contract with HEW but be unable to secure the legislation required for certificate-of-need. It is likely that Section 1122 will gradually atrophy, depending on the action that HEW takes against states which have not established an approved certificate-of-need program by the required date.

Appropriateness review

P.L. 93-641 requires HSA's to review all existing institutional health services in its area at least every five years and make recommendations concerning the "appropriateness" of those services to the SHPDA. HEW has chosen to require only area-wide appropriateness reviews, not reviews of individual institutions. Thus, it seems reasonable to conclude that existing medical information systems will not be affected. It is conceivable that note could be taken of shared systems (or the lack of them) in an area-wide review but this seems unlikely. The appropriateness review concept, in fact, seems quite weak and of questionable efficacy. It represents a "watered down" substitute for an original concept of requiring periodic recertification of facilities which was discarded by the Congress because of likely adverse effect on outstanding debt and capital markets for health care institutions.

Control of federal funds

Title XVI of P.L. 93-641 provides for allotments, loans, loan guarantees and interest subsidies for modernization of medical facilities, construction of new outpatient and inpatient medical facilities and conversion of existing medical facilities for new health services. This Title is essentially the lineal descendent of the old Hill-Burton program.

Responsibility is placed on the SHPDA for review and prioritization of projects proposed for support. It is possible that a medical information system might be included as part of such a project; however, the criteria are sufficiently limited as are the appropriated funds to make this a rather unusual occurrence.

Current certificate-of-need application deficiencies

CHAPTER 3

10

All Health Systems Agencies were surveyed for information concerning their procedures and hospital information system projects they have reviewed. Responses were received from more than half. The nature and content of these responses were highly variable so that no precise quantitative measurement of hospital information system review activity was possible. Seventy-four hospital information system project reviews were identified by this process. These ranged from notice of intent to submit Certificate-of-Need applications through the various stages of review to completed reviews. Again, the extent of information concerning these applications was highly variable, ranging from copies of the Certificate-of-Need application to brief line items appearing in HSA newsletters.

Despite the difficulties of quantification, these responses from more than half of the HSA's in the United States make it possible to draw certain conclusions concerning project application deficiencies for hospital information systems. Since it is the purpose of this guidebook to provide some helpful benchmarks for use by Health System Agencies, as well as petitioning hospitals, it is useful to identify and briefly discuss these deficiencies.

Failure to submit application

While it is difficult to assemble conclusive statistical proof from the data available, it appears likely that many hospital information systems are being acquired by hospitals without submission of Certificate-of-Need applications. In some cases, of course, such failures may be traced to the status of state legislation or HSA status. Others, however, are undoubtedly attributable to lack of awareness on the part of the hospital of the legal and regulatory requirements. For example, the author is aware from confidential data furnished by a vendor that 20 systems of a particular type were sold in 1978. Only two of these systems appear among the 74 applications noted above. While it is possible, of course, that the other 18 were all sold to hospitals under the cognizance of HSA's not responding to the survey, that possibility is considered unlikely. Rather, since hospital information systems typically involve no expansion in beds, nor addition of new services, it is possible that very often the judgment is made that no application is required. Such a conclusion is, of course, invalid. Another explanation may be that such systems are frequently leased or rented; hence, hospitals may (incorrectly) believe they are not subject to review.

Inappropriate data furnished

Most HSA's have published, usually in questionnaire form, standard data requirements for Certificate-of-Need applications. These data requirements are usually designed to elicit information relevant to an expansion in bed capacity or hospital services. Nearly all of the data elements in these questionnaires are irrelevant to a hospital information system application. Conversely, data of interest in such an application is not normally a part of the required data set. Therefore, the applications, while often voluminous, are usually dominated by irrelevant data, making it difficult, and in many cases impossible, to make any reasonable assessment of the application.

Non-hardware costs not considered

Hospital information systems typically consist of equipment (terminals, computers, etc.), software (computer programs and documentation), occupancy costs (floor space and utilities), and labor

costs (analysis, programming, training and operations). Yet, often applications address only the equipment costs, undoubtedly because they alone are seen as capital expenditures, bringing them under the purview of the Certificate-of-Need regulations. From a project review standpoint, however, it is obvious that all costs associated with the system must be considered in order to arrive at a rational judgment on the application.

Lack of hospital information system development plan

As will be discussed later, hospital information systems may be defined as serving the needs for both individual departments and, on at least three progressively more sophisticated levels, serving the needs of the entire hospital. It is important that a hospital have a rather clear master plan describing its ultimate hospital information system objectives. Then, each system acquisition step should be taken in the context of that plan. Yet, rarely do Certificate-of-Need applications reflect the existence of such a plan.

Failure to consider relevant alternatives

As suggested above, hospital information systems exist at both the departmental level and at progressively more sophisticated hospital-wide levels. Applications typically fail to consider these alternatives in terms of the immediate system acquisition objective, in addition to failure to relate it to an overall plan. Given the immediately desired system there is little evidence that hospitals are aware of or have considered even a majority of the alternative vendors or sources for such a system. Finally, these systems may be acquired in several different ways, having different cost and risk implications. Again, applications typically do not reflect awareness of these alternatives, much less a reasoned comparison and selection from among them.

Lack of line management involvement

Computers appear to be viewed as a technical subject best left to the data processing department. Many of the applications reflect authorship by data processing personnel, and indeed, not infrequently seem to have been written for the hospital by hospital information system vendors, suggested by identical wording among several applications for the same system. Yet, such systems significantly impact the work of affected hospital departments. Typically, however, there is no evidence that the managers of these departments or the administrators of the institution are strongly involved in the decision making process, or have committed themselves to realize the alleged benefits of the system to be acquired.

Absence of risk assessment

The risks associated with successful system implementation and benefit realization vary substantially among the different kinds of systems and methods of acquiring them. Rarely do the applications demonstrate awareness of these risks, much less analyze them. Data processing in hospitals has been far from a uniform success, most often because hospitals have undertaken technical tasks of major complexity and difficulty which prove to be beyond their managerial or technical resources. It seems essential that a careful assessment of the probable chances of realizing the hospital's objectives be carried out in advance of a commitment.

Inappropriate financial analysis

Typically, the applications contain an assessment of cost savings versus cost; often, these analyses are inappropriate and misleading. Failure to include all cost elements is one major cause; failure to provide any mechanism to translate potential benefits into realized benefits is another.

Specious economic claims

Claimed economic benefits are often inappropriate. A frequently recurring claim, and one upon which the justification for many system acquisitions appears to rest, is that of collection of "lost charges." A substantial portion of hospital costs is reimbursed on a cost, rather than charges basis. Clearly, "lost charges" has no bearing on Medicare, Medicaid and other cost reimbursement third party collections. Further, even where substantial revenue is collected based on charges, it is not in the interest of the community to spend money to improve collections. If a hospital is failing to bill for, say, 5% of its services, it will set its rates 5% higher to match total collection with total costs. Some distortion will occur among patient bills to the extent that "lost charges" are not randomly distributed. Procuring a medical

information system to improve charging precision will increase the cost of health care to the community with no associated increase in health care delivery productivity. Thus, collection of "lost charges" should be summarily rejected as grounds for economic justification.

These deficiencies create some doubt about the quality of decision making by hospitals preparing applications and by HSA reviewers. Much of the balance of this guidebook will be devoted to avoiding these deficiencies. The goal is not to criticize, but to seek intelligent, rational decision making by hospitals—decisions that will prove to be in their interest and those of the communities which they serve as well as meeting health planning regulatory requirements.

A certificate-of-need checklist

CHAPTER 4

Introduction

Chapter 3 identified a series of deficiencies commonly occurring in Certificate-of-Need applications for medical information systems. The remainder of the book will be directed toward eliminating, or at least minimizing, these deficiencies.

While there is no clear common denominator to the deficiencies to avoid, undoubtedly a significant cause is that the nature of medical information systems is somewhat at variance with usual subject of CON review which typically involves proposed expansion of services. Therefore, the application forms are only partially relevant to the body of information required for intelligent review.

Neither revision of existing forms nor creation of new ones to serve the need for additional, relevant information is advocated. Rather, use of a checklist by the reviewer is suggested.

Uses for the checklist

The checklist which is presented in the following section is intended to serve three purposes. First, it should serve to provide the reader with an overview of the subjects which are relevant to consideration of a medical information system review. As such, it is an outline of the remaining chapters, although not necessarily in sequence.

The second purpose of the checklist is to serve as an agenda for preliminary meetings between HSA representatives and hospital representatives. Agreement should be sought on which checklist items are particularly crucial to the proposed system review so that the subsequent application is responsive and a timely review decision can be reached. Ideally, such meetings should occur at the outset of consideration of acquiring a medical information system by the hospital because the goal is a good decision by the hospital, not merely a "good review" by the HSA.

Finally, the checklist should facilitate actual review of the submitted CON application by the HSA. If the desired goal is achieved in the preliminary meetings, the formal review should be routine. A number of the issues are outside of the usual CON application form but these can easily be incorporated as supplemental information.

Medical information system review checklist

The checklist is designed for the general case, and consequently, some judgment must be applied in its application. Acquisition of a payroll system will not require involvement by the medical staff. The skills of the hospital data processing staff may be irrelevant if a vendor developed and operated system is to be acquired.

Thus, in practice it might be useful to photocopy the checklist and mark those items relevant to the application under consideration. It is important to focuse on the few critical issues most affecting the likely outcome of the contemplated decision and not permit them to be obscured by copious irrelevant information.

Many of the issues in the checklist are easy to quantify and evaluate. Others defy quantification and may present difficulties to the reviewer in evaluation (e.g., leadership and commitment of administration). Yet, both the hospital and the reviewer must guard against ignoring the more subjective or quantitative factors. There is no correlation between ease of quantification and importance.

A. *Hospital Development Plan and System Objectives*
   1. Hospital development plan (5-10 years)
      a. Mission

1) Inpatient or outpatient services (primary, secondary, tertiary)
2) Teaching programs (MD, RN, technologist, etc.)
3) Research programs

b. Relationships
1) Merger
2) Shared ancillary facilities
3) Coordinated specialization
4) Teaching affiliations
5) Alternate organizational modalities (HMO's, etc.)
6) Shared medical information systems development/operations

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c. Physical plant
1) Hospital additions or rearrangements
2) Remote facilities
3) Multiple facilities
4) Other automated systems or equipment

d. Quantitative projections
1) Admissions
2) Occupancy
3) Length of stay
4) Ancillary outpatient visits
5) Clinic outpatient visits
6) Data specific to sizing selected systems

B. *System Selection and Acquisition*
1. Objectives
a. System category (hospital wide, departmental)
b. System level
c. Relationship to existing or future system
2. Selection team—organization and participation
a. Administration
b. Data processing
c. Industrial engineering
d. Nursing
e. Major department needs
f. Medical staff
3. Alternative systems evaluated
a. Vendor and candidate systems (benchmarks and others)
b. Proposals received
c. Hospital visits (where, similarity to own hospital, etc.)
d. Use of candidate systems by evaluators
e. Reference checking
1) Candidate system (all or many user hospitals)
2) Vendor (experience, integrity, financial resources)
f. Evaluation procedure (factors, weighting, scoring, etc.)
4. Acquisition alternatives
a. Approach selected
1) "Do-it-yourself" development
2) Packaged software
3) Vendor installed
4) Vendor installed and operated—facilities management
5) Vendor installed and operated—service
b. Risks
1) Is the hospital contractually paying for input or output?
2) Responsibility for mandatory changes
3) Growth limitations
(a) Activity and services—sensitivity analysis
(b) Higher level systems

C. *Financing Alternatives*
1. "Unbundled" cost elements
2. Cash purchase
3. Vendor financing
a) Rental
b) Rental/purchase
c) Installment purchase
d) Financial lease
4. Third party financing
a. Unsecured loan
b. Secured loan
c. Operating lease
d. Financial lease

D. *Personnel Requirements.* (for selection, implementation, use/operations and benefit realization)
1. Administration
a. Leadership
b. Commitment
2. Data processing
a. Skills
b. Experience
c. Consultants
3. Industrial engineering

4. Nursing—professional (RN, NP, LPN, NA) and non-professional (clerks, etc.)
5. Department heads
6. Medical staff
   a. Leadership—officers
   b. Attending staff
   c. House staff
   d. Hospital-based (radiologists, pathologists, etc.)
7. Intra-hospital relationships
   a. Communications
   b. Openness
   c. Participative decision making
   d. Board-administration relations
   e. Medical staff—administration relations
   f. Intra-medical staff relations
   g. Management group relations
   h. Administration—nursing relations

E. *Financial Feasibility*
1. Assumptions
   a. System life
   b. Inflation rate (by year and by cost and savings element)
   c. Installation schedule
   d. Benefits realization schedule
   e. Financing method and cost
2. Costs (see Table 9-1 for more detailed checklist)
   a. Equipment
   b. Facilities
   c. Software
   d. Maintenance
   e. Utilities
   f. Taxes and insurance
   g. Training
   h. Supplies
   i. Management
   j. Industrial engineering
   k. Labor fringe benefits
3. Benefits (see Table 9-2 for more detailed checklist)
   a. Realizable labor savings
   b. Supplies
   c. Previous system costs
   d. Interest costs
   e. Capital facility costs
4. Risk
   a. Critical variables
      1) Identification
      2) Range
   b. Sensitivity analysis
5. Analysis
   a. Discounted cash flow return on investment method
   b. Present value method
6. Analyzing partial systems
7. Relating financial costs to non-financial benefits

F. *Research—Special Consideration*
1. Materiality (predominant use—patient care vs. research)
2. Financial support
3. Marginal costs
4. Organizational control
5. Incremental development

Assessing system alternatives

CHAPTER 5

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Introduction

Chapter 2 noted the requirement established by Public Law 93-641 that the HSA review process explore "availability of less costly or more effective alternatives." The purpose of this chapter is to provide a basis for such an exploration. To do so, this chapter will outline a method for categorization, provide some definitions, set forth a useful categorization system, and finally, provide a list of system vendors. With this background, the reviewer should be able to categorize a hospital application for a medical information system under the review and determine whether at least the major alternatives have been identified and assessed.

Categorizing systems

Computer systems utilized in hospitals range from those intended for specialized computational purposes, such as calculating radiation therapy doses in the radiology department, to comprehensive hospital-wide information system automating much of the information processing associated with inpatient and outpatient care. Accordingly, it is helpful to develop a system or a methodology for categorizing systems. These categories represent useful labels for communication, and they also can be used as "building blocks" in constructing and assessing the hospital development plan (which will be discussed in Chapter 7).

Any meaningful consideration of alternatives must be made within the confines of a given category to permit like comparisons. Caution must be exercised, however, in utilizing any categorization system. The variation among systems is almost endless. Hence, it is likely that no system will entirely fit into a single category. Instead, the more usual circumstance is to find that a system predominately fitting into one category will have certain features usually found in another category. Also, the assumption should not be made that systems which are assigned to the same category are equivalent. Indeed, they are not. They will vary considerably in scope, depth, and excellence of technical execution. These limitations must constantly be borne in mind in any discussion of system categories.

Some definitions

Before proceeding further, it is useful to provide some basic definitions of computer systems terminology for readers lacking familiarity with the computer field. It is useful to think of a computer system as consisting of input/output devices, a processor, a memory, and a set of programs. While computers may create an image in the reader's mind of complex mathematical computations (which indeed is one of their functions), their more common application in hospitals is for communicating information from one point to another at the desired time and in the desired format. Hundreds of laboratory test orders may be consolidated, for example, to produce a 6:00 a.m. laboratory specimen pickup list. Computations may also be involved, but they rarely are more complex than arithmetic computations, such as calculating a patient's bill. Therefore, a medical information system is in reality a powerful communications system, rather than simply a super calculator.

Processing may be done in either a batch mode or a real time mode. "Batch mode" refers to the collection of a large group of similar transactions and then processing them at a given time in a single batch. "Real time processing" involves processing each transaction as it occurs. Each mode of processing has its proper application. For example, computation of the hospital payroll demands batch

processing, while transmission of stat X-ray orders from the emergency room to the radiology department requires real time processing.

Another distinction among computer systems is on-line versus off-line processing. "On-line" refers to the direct connection between a user-operated input device and the processor. This may, for example, be a keyboard terminal wired directly into the computer. Off-line processing implies use of a document, for example, a payroll time card, which is then physically transported to the computer and translated into computer language by keying at a later time.

Equipment required is varied and consists of the computer, including its processor and memory, input devices and output devices. Computers range in size from so-called maxi-computers filling large rooms to bread box size mini-computers, to microprocessors, the so-called "computer on a chip." While important technical distinctions exist which are beyond the technical scope of this book, no general conclusions can be drawn concerning the superiority of a given type or class of computer. Emphasis should be placed on what a system does and how well it performs these tasks rather than on the kind of computer it employs.

The most common off-line input device is the key punch or key tape machine by which manually recorded alpha numeric data is translated into machine-readable form by keystrokes. The keyboard terminal, equipped with a cathode ray tube (CRT) display, performs a similar function, and in addition, is tied on-line to the processor, eliminating any intermediary form of storage such as punched cards or punched paper tape or magnetic tape. Automated document reading is possible by use of mark sense readers or optical character recognition devices. These are useful, for example, in reading laboratory values that have been recorded on forms by technologists back into the medical information system. Finally, the light pen, combined with a cathode ray tube, is an extremely powerful input method, permitting selection from among displayed alternatives by simply pointing a pen-like device at the desired word or phrase. This latter device is especially useful for personnel lacking typing skills. Output from a computer may be so-called "hard copy," printed documents which may be produced at either a centralized printer in the computer facility, or on printers located at appropriate work sites throughout the hospital. Or, output may be presented to the user via a cathode ray tube or television-like display when no permanent record is required.

"Software" is used to describe instructions which control the performance of the "hardware" (the equipment) in a computer system. Computer equipment is analogous to a musical instrument, particularly an automated one such as a player piano, while software is analogous to the musical composition. While obviously the result is a function of both components, it is not unreasonable to state that the software component tends to be much more important in determining the ultimate performance of a system.

Narrowly defined, software consists of computer programs. "Operating system" programs are those which control the machine and its various devices, such as loading programs, running programs, printing, error checking, etc. "Application" programs are those which cause the computer system to perform the function desired by the user. A broader definition of software would also include system analysis; that is, the review of, say, the hospital admitting procedures and recording these procedures in a precise, structured format, including all variations and options, which would then be translated into applications programs by the computer programmer. This broader definition might also include user education and user documentation, because without these latter components, even a well designed system may not be effectively used.

Departmental versus hospital-wide systems

The first important categorization is to differentiate between systems designed to support the needs of a single hospital department versus systems that are comprehensive, or hospital-wide in their intended application.

An analysis of information processing functions within the hospital reveals that within each department a portion of the tasks are entirely internal to the department, but another significant portion requires interaction with other departments or access to common data such as admission lists, bed assignments, etc. Further analysis makes it apparent that there are also interactive effects between departments. For example, a radiology order written by a physician for an upper GI series implicitly affects the dietary department because of the need for withholding breakfast from the patient. Certain

medication orders may affect test results in a clinical laboratory. Countless other examples will occur to the reader. Although a hospital is conveniently organized into departments for management purposes, an analysis of the information required for the effective care of patients and management of the institution soon suggests that the whole is much more than the sum of the parts. This leads to the conclusion that the optimum application of information systems technology of the hospital is on a comprehensive, or hospital-wide basis.

One approach which may suggest itself to the reader is to install a series of departmental systems—admitting, laboratory, pharmacy, radiology, nursing, medical records, etc., and then at some appropriate point in the future tie these systems together into an integrated system. This is sometimes referred to as the "modular approach." Unfortunately, while it is an attractive concept, and looks very good on planning charts, it has proven in practice to be difficult and elusive. Tying computer systems together is not a simple task, particularly if the systems were designed and developed independently. Access to common files may prove to be a problem. Operation in the presence of failure in one or more of the systems and subsequent recovery following repair represents another difficult problem. In general, then, the modular building block approach should be viewed with some skepticism. It can be safely adopted by a hospital only when that hospital can find a previously successful implementation and integration of the specific departmental systems under consideration which it can emulate. The risks of undertaking it on any other basis are not insignificant.

Because of these difficulties, a hospital is usually best advised to carefully plan a hospital-wide system before acquisition of any departmental systems. For a more modest beginning, it may be possible to acquire components of a desired hospital-wide system, but the hospital should assure itself that it can add additional capability at a later date by directly observing the more complete system in satisfactory operation in other hospitals. Claims that dissimilar systems can be tied together or "interfaced" should also be verified by observation.

At least two common exceptions exist to the general philosophy just outlined, where departmental systems may represent an appropriate approach. These are in the business office and in the clinical laboratory. Both of these departments have exceptionally heavy internal data processing requirements, and very well developed systems exist to satisfy these requirements. Satisfactory interfacing to hospital-wide systems has been demonstrated, although the task is much more difficult in the case of the clinical laboratory system than in the case of the business office system where interfacing can be, if necessary, performed off-line without significant compromise to overall capability.

The business office system was, in fact, the first major application of computer technology to hospitals, and was in large measure a consequence of the reporting requirements resulting from the Medicare/Medicaid Amendments to the Social Security Act of 1965. A recent survey found that 93% of the hospitals surveyed were using computers in their business offices. Typical functions which are included in business or financial management systems are patient billing, accounts receivable, payroll and personnel, accounts payable, general ledger, and inventory control.

Examples of other departmental systems may be identified such as pharmacy and radiology systems, but these are at least an order of magnitude less common than laboratory or business office systems.

Benchmark systems

In discussing each category or system it is useful to identify several "benchmark" vendors. The purpose is to provide a practical test for use by the reviewer in determining whether a reasonable assessment of alternatives was made by the hospital. These benchmark systems are chosen from the most widely employed in the field in their category, and hence, it would be reasonable to infer that any assessment of alternatives carried out by a hospital which did not include one or both of them would be incomplete, just as we would be skeptical of any claim that a reasonable assessment of automobile alternatives had been made which failed to include General Motors or Ford. *It is not suggested that these systems should necessarily be the system of choice for the hospital.* No such evaluation has been made to support this conclusion. To reiterate, *no endorsement of the benchmark systems should be inferred*; they are included *solely* as a measure of the extent to which alternatives were considered in a CON application.

The benchmark business office systems are those offered by Shared Medical Systems and the McDonnell Automation Company. These systems are pro-

vided as "services" (a method of acquisition discussed in the next chapter) and are utilized in hundreds of hospitals throughout the United States.

Clinical laboratory systems came into use only a few years after business office systems. These systems begin with laboratory test requisitions and generate specimen logs, specimen pickup sheets, work sheets, load lists, laboratory reports, quality control reports, test logs, etc. While less pervasive than business office systems, they have been acquired by hundreds of hospitals over the past decade.

No independent studies are known to the author which document their cost effectiveness; however, most hospitals which have installed them have claimed savings offsetting their cost. Since laboratory tests typically grow at a rate of 15% per year or more, many laboratories have argued that these systems have permitted accomplishment of this continually increasing workload with less than a proportional growth in laboratory work force. Quality improvements have been reported, both in the reduction of errors and in speeding the availability of laboratory test results to clinicians.

Benchmark systems in the laboratory area are those developed by Community Health Computing and by Technicon T & T Corporation, particularly the LDM-8000 system.

Hospital-wide systems

The hospital-wide systems are typically on-line, real-time systems utilizing some type of cathode ray tube terminal at each major work site, and often include printers at these work sites. Accordingly, these systems appear similar to the casual observer, at least at a superficial level. They vary significantly, however, in cost, performance, and growth potential. The least sophisticated and capable of these systems will represent an investment measured in a few hundred thousand dollars while the most extensive will require investment of many millions of dollars. Therefore, it is in this area the HSA reviewer must particularly focus attention.

It is convenient to categorize the hospital-wide systems into three categories or levels—levels 1, 2, and 3. As noted earlier, any categorization system is somewhat blurred in actual use as system developers cross category boundaries. Nevertheless, this three level categorization system is quite useful.

Level 1 systems are the least expensive and least capable systems available to the hospital. They are sometimes called "data collection" or "charge collection" systems. These systems place input terminals in admitting, at the nursing stations, and in the principal ancillary departments. Output printers are located in at least the major ancillaries such as laboratory, pharmacy, and radiology.

Level 1 systems perform two basic functions. First, they are used for message communication. Patient admissions data is entered via a terminal in the admitting office, and the admitting notice will print out at the appropriate nursing station, and in the ancillary departments. Physician orders are transcribed from the order sheet by a terminal operator (usually a unit clerk) through a keyboard terminal and will print out in the appropriate ancillary department. For example, a laboratory order typed into the nursing station terminal will print out on the laboratory printer.

The processing capability of the system is utilized to format these messages as desired. For example, a laboratory order may be printed as a combination specimen label and work sheet. A computer record is made of all orders transmitted by the system during the 24-hour day. At midnight, or some other designated cutoff time, this computer record is then fed into the hospital business office system. Thus, charge collection is performed in addition to message communication.

Level 1 systems typically possess three common characteristics. First, their storage capability is limited to a single day. After messages have been transmitted from the point of origin to destination, only the charge record is stored and that record is erased following transfer to the business office system. Thus, there is no capability to review medical orders in effect on a patient over a few days or his entire stay, or to review laboratory or other results from previous days. Second, terminal input is characteristically performed by keyboard selection from among choices stored external to the system. For example, laboratory tests performed by the hospital's laboratory may be listed in a Kardex or in a printed directory with appropriate codes. The terminal operator looks up the desired tests and enters the appropriate code through the terminal. This method of entry reduces storage requirements in the system, and of course, contributes to lower cost but is rather slow and requires special operator skills. The third characteristic of level 1 systems is that their use is almost invariably restricted to non-professional, clerical personnel. This follows both from

their limited functions, largely message communications, and their rather tedious methods of input which are unlikely to be acceptable to a busy professional.

An evaluation is presently underway at the University of Southern California of level 1 systems under a grant from the National Center for Health Services Research. This evaluation will endeavor to measure cost effectiveness of these systems. Since economic justification for these systems sometimes depends on capture of "lost charges," care must be exercised in analyzing their economic impact.

20 Careful review of these systems should also include consideration of their suitability for upgrading into level 2 and 3 systems. Because of the limitations of both the terminals and the processors used in level 1 systems, it is not clear whether such upgrading can be achieved, and no good examples of successful upgrade are known to the writer. This question of technical upgrade ability is also a subject of the Southern California grant noted above.

Because of their low cost and limited impact on the medical staff, level 1 systems have found the widest application among the hospital-wide systems. Suggested benchmark systems are the Huff, Barrington and Owens MedPro system and the McDonnell Automation Company's HDC system.

Level 2 systems differ from level 1 by removing two of the basic constraints associated with level 1. Level 2 systems contain adequate storage capability to maintain data on all active inpatients as well. Therefore, data covering any part or all of the patient's stay in the hospital may be retrieved from any terminal in the system. This added storage capability greatly expands the useful applications. For example, tomorrow's radiology workload may be examined and cumulative laboratory test reports on a patient may be produced.

Second, level 2 systems typically store within the system the array of choices which may be made by the terminal operator, in contrast to level 1, where the array of choices is stored in some externally printed form. For example, all drugs contained in the hospital formulary could be displayed on the screen, permitting the operator to select the one corresponding to the drug order written by the physician on the medication sheet in the chart.

Like level 1 systems, level 2 systems are designed for use by terminal operators rather than medical professionals. Therefore, terminal entry techniques may involve special skills such as typing or use of data codes. Even where light pen or touch terminals not requiring typing skills are used, level 2 system displays are organized for efficient use by non-medically trained clerical personnel. This means, of course, that each terminal in the hospital must be supplied with an appropriately trained operator on each shift in which it is anticipated that the terminal will be in use. This terminal operations function can be combined with other duties such as including it among the tasks of the unit secretary at the nursing station. There is, nevertheless, a fundamental requirement to transmit all information from physicians, nurses and other professionals through intermediaries which has adverse cost implications. This also creates quality limitations arising from the necessity of transmitting professional information through non-professionally trained intermediaries. Since information generated by professionals cannot uniformly be relied upon to be legible, complete and unambiguous, interpretation by intermediaries is not without risk. This use of intermediaries also, of course, constrains the potential functions that this system can perform. Certain functions are simply impractical if an intermediary must be relied upon. Certain benefits which uniquely arise from the professional interacting with the data contained in the system concerning a patient are also precluded.

Level 2 systems result in reduced errors and greater timeliness in the delivery of care results. Productivity gains occur, but they are to some extent offset by the cost of intermediaries. An individual hospital assessment, which we will describe in Chapter 9, will be required to make a reasonable estimate of cost effectiveness. The benchmark systems suggested as representative of level 2 are those offered by National Data Communications and Datacare.

Level 3 systems represent the most ambitious and far-reaching comprehensive medical information systems. They differ from level 2 systems in that they are designed for *direct* use by physicians, nurses, and other health care professionals. They are designed on the premise that most activity in a hospital stems from physicians' orders and is ultimately aimed at functions performed for the patient or resulting in information which is returned to the physician for use in further decision making. Since an important subset of this same clinical information is utilized by nurses in carrying out physicians' instructions and making clinical observations, direct use by nurses is also emphasized.

Level 3 systems combine high performance terminals with displays organized in natural and logical medical language with which physicians and nurses can communicate as fast or faster than they could previously with handwriting in traditional manual information processing. It has also been found necessary to achieve this communication facility with only the most minimal training in order to achieve acceptance.

The level 3 system thus eliminates intermediaries in medical communications. Further, by placing the physician and nurse in direct interaction with the system, additional system functions are now possible. The level 3 system thus has the greatest impact on altering the manner in which care is delivered in a hospital. Because of the additional terminal capability required, as well as a greater number of functions now performed, level 3 systems are the most expensive of the hospital-wide systems. Conversely, however, their benefits may be anticipated to be the greatest.

A level 3 system has been extensively studied in a National Center for Health Services Research sponsored eight year study of the Technicon Medical Information System installed at El Camino Hospital, Mountain View, California. This study had been carried out under contract by both the hospital itself and by the Battelle Columbus Laboratories. Significant patient care benefits have been reported as reflected by greater accuracy, timeliness and completeness. Economic studies have indicated productivity gains approximating the cost of the system. Given the incentive structure which exists in a hospital community under present legislation, this evaluation could not determine if additional savings beyond those necessary to pay for the system and remain competitive in the local hospital community could be realized. The interested reader is referred to the El Camino and Battelle reports which are cited in the bibliography (Barrett et al. and Gall).

The Technicon Medical Information System, which was the subject of the aforementioned evaluation studies, is a benchmark for level 3 systems. A second suggested benchmark is the Medicus Corporation Spectra System, which was also designed for direct professional use.

System selection

While a detailed plan for system selection by the hospital is not the purpose of this publication, but rather was a subject of an earlier book by the author (*Medical Information Systems*, Aspen Systems, Germantown, Maryland, 1977) certain selection principles are suggested here. The violation of these principles may give the hospital executive or HSA reviewer some cause for concern.

It will be suggested in the next chapter, in considering acquisition alternatives, that most hospitals are well advised to select from among the various vendors of developed systems in contrast to undertaking system development within the hospital. This implies the necessity for evaluation of vendor developed systems.

The first caveat in undertaking such a selection is to be certain that all importantly affected groups in the hospital are well represented. Just as, "war is too important to be left to the generals," medical information systems are too important to be left to the computer experts. Therefore, the selection group should include representation from administration, medical staff, nursing, clinical laboratory, pharmacy, radiology and the business office. The designated team should collectively comprise a group in whom the balance of the organization will have confidence. As will be noted in a later chapter, the installation of a comprehensive medical information system in a hospital is potentially a behaviorally traumatic event. Participation of all affected personnel in decision making is, of course, a proven method of minimizing such trauma. Also, the varied experience of the members of the aforementioned groups is required to make a reasonable assessment.

After organization of selection groups, if a long-term hospital development plan for medical information systems does not already exist, construction of such a plan should be the first task of the selection group. Consideration should be given to a long-range plan which culminates in a level 3 system to avoid later encountering a cul de sac; however, whether such a goal is established or not, the long-range plan should be developed in accordance with the principles which will be discussed in Chapter 7.

Then, on-site visits should be made to hospitals employing systems representative of various stages in the long-range plan. At a minimum, site visits should be made to hospitals utilizing one, or preferably both, of the suggested benchmark systems. Other systems in the category of interest should also be visited. Later in this chapter we will present a comprehensive list of systems. Specific suggestions might also be obtained from the American Hospital Association.

In seriously examining a given system, visits should be made to at least two hospitals employing the system. Particular care should be exercised in drawing conclusions at the hospital site where the system was developed because of the singular by-products of the development process. The development site hospitals will on one hand have suffered from the usually unavoidable trauma of development error, and on the other hand, reflect pride in "their" system. Where options exist, hospitals visited should be those judged the most similar to the evaluating institution. Check lists should be drawn up in advance of visits to be sure that all relevant questions are considered. Professional matchups should be made; i.e., physicians with physicians, nurses with nurses, laboratory technologists with laboratory technologists, etc.

An almost ideal method of evaluation is to arrange with the hospital possessing a system of interest for personnel from the evaluating hospital to work for several days in the hospital utilizing the system. Much can be learned by physicians making rounds with other physicians using a system. A week spent by a nurse working at a nursing station utilizing the system is infinitely more valuable than a 20-minute tour. While such a significant investment of time is undoubtedly practical only for in-depth evaluation of one or two "finalist" systems, it is strongly suggested that it be considered.

A dangerous trap in system evaluation is consideration of "features." The fact that a system claims to have, say, an "adverse drug interaction system" is almost meaningless unless an evaluation is carried out on just how the system performs. Stated differently, the depth and sophistication of performance of a given function is much more important than the array of "features." Depth can be rather easily assessed by attempting to handle a half dozen or so real patients' data with all the attendant "real world" complications and exceptions via the systems. "Shallow" systems will simply prove to be incapable of handling the data effectively. This makes comparison charts a rather dangerous evaluation tool when not backed up by on-site, in-depth exploration of functions.

System vendors

Table 1 summarizes the offerings of 158 vendors as of 1978. This table was constructed by David K. Tao at Washington University School of Medicine, St. Louis, under a grant from the National Center for Health Services Research.[1] *No implied endorsement is intended for any system contained in Table 1.* Indeed, many of the listed systems are unfamiliar to the author. *Nor, to reiterate, is any endorsement suggested for any of the benchmark systems identified earlier.* Since any listing of this kind becomes rapidly dated, it is suggested that its use by hospitals be supplemented by checking with the American Hospital Association or other sources of current information. Table 2 contains vendor names and addresses. The tables and notes making up the rest of this chapter are taken directly from the Tao report.

Notes to table 1

(a) Implementation type: F = Facilities Management; I = In-House (on-site) computer system; S = Service Bureau (off-site). Where blank, the information was not obtainable from information supplied by the vendor. Facilities Management involves vendor responsibility for operation of the client's computer facilities. In-house systems may be installed by a vendor, but are subsequently operated by the client's staff. Service bureaus provide access to processing on a computer located at the vendor's site. In some cases, notably hospital "distributed processing" systems, a minicomputer may be installed at the hospital, connected by telecommunications to a "host" computer at a remote site. Vendors offering this arrangement are considered both type "I" and type "S".

(b) Number of Clients: Clients either currently using or committed to using the vendor's medical applications software, according to the vendor's estimate. An asterisk (*) indicates that the vendor provided names of some clients (and presumably would also do this for a prospective customer). Where blank, information about number of clients was not given.

(c) Customizing: A rough indication of the answer to the survey question: "Approximately what percentage of your software-development effort is spent in custom-tailoring to meet individual requirements?" The codes: A = 51% or more; B = 21% to 50%, C = 20% or less. Where blank, the question was not answered. Many vendors had difficulty interpreting this question, especially in the cases of "profile-driven", or "parameterized" programs, which allow users to tailor programs to their own situation, but do not involve extra custom programming by the vendor.

(d) Billing/accounting: Actually includes all business functions related to *patients*, such as accounts receivable,

[1] Tao, David K. *Computer Applications in Medicine – A survey of Vendors.* Washington University School of Medicine, St. Louis, Mo. February, 1978.

Table 1.

Vendor	Impl. Type (a)	Emphasis					No. of clients (note b)	Customizing (c)	Application Area					
		Clinic	Hospital	Lab	Pharm	Other			B/A (d)	Mgmt. (e)	Sched. (f)	Ancillary	MR(g)	Other (h)
Abacus Data Systems							0	A	X	X				
Abbott Diagnostics Division	1			X			32*	C				X		
Academic Computing Corp.	F, 1	X	X				8*	B	X	X	X	X		
Accucom Data Inc.	S	X					20	C	X	X		X		
ADP (Automatic Data Processing)	S	X					50	C	X	X				
Advanced Medical Systems	F, 1, S		X	X			22*	B	X	X	X	X	X	a, b
Alex Riverbank Associates Ltd.	1	X	X					B	X	X	X	X	X	X
All Type Systems Inc.	1	X	X				9*	C	X	X	X	X		X
Ames Color File Corp.	1		X				3*	C	X	X			X	
AML International	1	X	X				45*	B	X	X	P	P	X	s
Analytic Associates					X		3*	A				X	X	
Appalachian Computer Services	S	X					86	C	X	X				p
Artronix, Inc.	1, S	X	X				200	C	X		X	X	X	u, x
B-D Electrodyne	1		X				14*	B				X		m
B-D Spear Medical Systems	1		X	X	X		41*	C				X	X	
Bac-Data Med. Information Sys	S		X				300*	C						f
Basic/Four Corporation	1		X				4*	C	X	X		X	X	
Beehive International	1		X				9*	B	P	P		X	P	ceg, imv
Biomedimation Corp.	1, S	X	X	X	X		7*	B		X	X	X	X	a, t
Burlington Data Processing	1, S	X					65*	C	X	X	X			
Burroughs Corp.	E, 1, S	X	X	X	X		300*		X	X	X	X	X	a
Business Information Sys., Inc.	1	X	X				25*	C	X	X	X	X	P	P
CCS (Computer Consulting Svc)	1, S	X					125	C	X	X	X	X		e
CDI (Computer Dynamics Inc)	1	X					30*	B	X	X	P			
CGR Medical Corp.	1	X					1*		X	X	X	X	X	
CHART, Inc.				X			0	B	X	X	P	P	X	X
CHC (Community Health Comput.)	1			X	X		10*	C				X		
Clinic Services Corp.	S	X					75	B	X	X	X	X		
Commercial Data Services		X					20*	A	X	X	P			P
Commercial Data Systems							1		P	P			P	P
Compas Medical Systems Inc.		X					12	B	X	X	P	X	X	X
Compucare, Inc.	F		X				2*		X	X	P	X	X	a, l
Computer Concepts & Svcs. Inc.	1	X					7*	B	X	X		P		
Computer Laboratory Services										X		X	X	
Computer Medical Corp.		X					200*	B	X	X		X	X	
Computer Sciences Corp.	F, 1								P	P	P	P	P	X
Computer Synergy	F, 1		X				50	A	X	X	P	P	X	a
Coulter Electronics	1		X	X			3*		X	X		X		
Creative Socio-Medics	F, S	X	X				250*	A	X	X	X	X	X	
CSM Medical Devices	1	X	X				30*	C			P		X	
Cybermed Corp.	1			X			3*	C				X		
D'S[illegible] Company	1		X				2*	B	X	X				a
Datacare, Inc.	F, 1		X	X	X		3*		X	X	P	X	X	a
Data Service Agency Inc.	S	X					500*	C	X	X		X		
DATX	1		X				4*		X	X		X	X	a
Delair Data Systems	1		X				6*	B	X	X	X	X	X	

Table 1. (Continued)

Vendor	Impl. Type (a)	Emphasis					No. of clients (note b)	Application Area						
		Clinic	Hospital	Lab	Pharm	Other		Customizing (c)	B/A (d)	Mgmt. (e)	Sched. (f)	Ancillary	MR(g)	Other (h)
Digital Equipment Corp.	1			X								X	X	X
Diversified Computer Applic.	S		X				140	C	X	X			X	
DNA (Diversified Numeric Apps.)	1		X	X	X		30*	B	P	X	P	X	X	a, i
Doctors Office Comp. Svc. Inc.		X					8*	C	X	X	X	X	X	P
Edelman Systems Inc.	1	X					75		X	X	X		X	
Employers Insur. of Wausau, MSSD	S	X					175*	B	X	X	P	P	P	P
Florida Software Services							6*	B	X	X		X	P	X
General Electric Med. Sys. Div.	1	X	X			R**	50*	C	X	X	X	X	X	
Gamma Systems Services	1		X		X		7*	A	X	X		X	X	
General Automation Inc.	1		X				20*	A	X	X	X	X	X	c, e, 1
General Computer Corp.	F, 1		X	X	X		11*	B	X	X	P	X	X	a, i
Genetron, Inc.			X				6*	C	P	X	X	X		a
Hamlin, Williams & Associates	1	X	X				4*	A	X	X		X		X
HBO & Company	1		X		X		94*	A	X	X	X	X	X	a, 1
Healthgarde Corporation			X	X			50*	B		X		X	X	1
Health Care Computer Sys. Ltd.					X		10*	B	X	X		X		
Health Care Systems (NC)							50	C		X			X	
Health Care Systems (MN)	S	X					125*	A	X	X	X	X		
Health Control Corp.	1	X	X				26*	B	X	X	X	X	X	a, i
Health Management Corp.		X					10	A	X	X		X		
Hewlett-Packard Co.	1		X				200	C				X	X	c, e, m
HMS Medical Services	1, S		X				100*	B	X	X	P	X	X	a, i, p
Honeywell, Inc.	1	X	X	X			400*	C	X			X		
Hospital Computer Systems Inc.	F		X				4*	A	X	X	P	P	X	a
Hospital Data Ctr. of Virginia	S		X	X	X		22	B	X	X	P	X	X	a, b, p, s
Hospital Financial Svcs. Inc.			X				85	C	X	X	X			
Huguelet Systems Corp.		X					6*	B	X	X	P		P	
I.B.M. Corporation	1	X	X						X	X		X		a, i
ICS (Integ. Comm. Sys. Inc)	1		X				5*	B			X			h
IDS (Interpretive Data Sys.)		X	X				15*		X	X	P			a
Informatics, Inc.							1*	C	X	X				
Info-Data Inc.							50	B	X	X	P		P	
Intellectron International Inc.	S	X					650	C	X	X	X	X		
Interactive Systems Inc.	1		X	X	X		12*	B	P	X	P	X	P	a
Interactive Sys. & Mgmt. Corp.		X					5		X	P	P	P		
Johnson Controls Inc.	1		X											h, k
Kaman Sciences Corp.	S	X					25*	A	X	X	P			
Kuhn, Olsen & West		X					13*	C	X	X		X	X	
Larry Chittenden & Associates			X				3*	C	X	X				
LCI (Laboratory Computing Inc.)	1		X	X			35*	C				X		
Lockheed Electronics Co.	1	X					10*	C	X	X		X	X	
Logic Systems Inc.	F, 1, S	X					50*	C	X	X	P	X	X	s
M D (Medical Datamation) Corp.	S						250*	C		X			X	P
Management Systems Inc. of Amer.	S	X						B	X	X	X	P	P	
Management Systems Tech. Inc.	1				X		18*	C				A		
MBS (Midwest Bus. Statistics)		X					1500	B	X	X	X	X	X	

R** = Radiology.

McDonnell Automation Co.	F, 1, S		X			400*		X	X		X	X	a, e, i
MCSI (Med. Computer Syst. Inc.)	1, S	X				200*	B	X	X	X	X		
MCS (Medical Computer Sciences)	1		X			11*	A	X	X		P	P	a, e, i
MDC (Medical Data Consultants)						7*	B	X	X	X	X	X	f
MDI (Medical Dimension Inc.)	S		X			10	B	X	X	X	X		a, i
MECA (Med. Comp. Applic. Corp.)	1		X			1*	C	P	X	P	X	X	a
Medatran	1	X	X				B	X	X			X	
Medcomp Research Foundation						4*	A	X	X	X	X	X	
Medical Data Research	1	X				12*	C	X	X	P	X	X	
Medical Data Services (VA)	1	X	X			300*	C	X	X	P	X	P	
Medical Data Services Inc. (TN)							C	X	X	P	X	P	
Medical Data Systems (MI)	1		X			195*	C						n
Medical Scientific Internat'l			X			4*	B	P	X	P	X	X	X
Medicus/Spectra Medical Systems	F, 1		X	X	X	40*	B	X	X	X	X	X	a, d, i
Meditech	F, 1, S	X	X	X	X	140*	B	X	X	X	X	X	a, c, i, t
Medi-Matic		X				65	C	X					
Medlab Company	1		X	X	X	25*	C		X		X	X	c, e, l, m
Medtek Data	S	X					C	X	X	X			
Med-Data Systems Inc.	1	X				55*	A	X	X	X	P	P	
MRI (Medical Resources Inc.)	S	X				15	A	X	X	P	P	P	P
MSA (Mgmt. Science America)			X			50*	C	X	X				
MCS (Management Systems Corp)	F, 1, S		X			40*	B	X	X		P	X	a, i, p
Medical Data Syst. Corp. (OH)	S					65	C	X	X	X		X	
National Data Communications	F, 1		X	X	X	7*		X	X	X	X	X	a, i
NCR Corporation	1	X	X			300*		X	X	X	X	X	a
NLT Computer Services Corp.		X				30	A	X	X	P	X		X
Northrop Data Systems	1	X		X		75*	B	X	X	X	X		
Northwest Data Systems		X				120*	C	X	X				
Occidental Computer Systems	1	X	X			550*	C	X	X	X	X	P	t
Omega Systems	1	X				5*	A	X	X	P	P	X	
Orion Systems Corp.	1	X				25*	C	X	X	P	X		
P. L. Clark & Co.		X				4	A	X	X	X			
PAM (Professional Acct. Mach)	1	X				13*	C	X	X	X	X		
Pelam, Inc.	1	X	X			8*	C	P	P	P	X	X	s
Pentamation Enterprises	F, S		X			40*	B	X	X	P	X	P	a, i
Phone-A-Gram System	S	X	X			1500*	C						e
PHS (Professional Hosp. Svc.)	1		X			50*		X	X				
Professional Billing Corp.	S	X				54*	C	X	X	P			P
Professional Business Services		X				100*	A	X	X	P			
Professional Health Research					X	500*	C				X	X	r
Professional Management Corp.	S	X				225*	A	X	X		X		
Pursinger Company						8	C	X	X	X	P	X	
Quanta Systems Corp. (Med equip)	1	X	X			12*	B	X	P	X		X	a, s
Rapid Medical Services		X	X			7*	C	X	X	X	X	X	X
Roche Medical Electronics Inc.			X				B					X	
S-Tek Computer Service Inc.	1, S	X				4*	C	X	X	P	X	P	
Safecom, Inc.	S	X				70*	C	X	X				
SAI (Systems Associates Inc.)	F, 1		X			50*	B	X	X				a, i, p
SDC (Science Dynamics Corp.)	S	X				260*	A	X	X	X	X	P	
SDK Med. Computer Services Corps		X	X			50*	C	X	X			X	i
Searle Medidata						45*	B						s
Shared Medical Systems Corp.	1, S		X	X	X	400*		X	X	P	X	X	a, i

Table 1. (Continued)

Vendor	Impl. Type (a)	Emphasis: Clinic	Hospital	Lab	Pharm	Other	No. of clients (note b)	Customizing (c)	Application Area: BIA (d)	Mgmt. (e)	Sched. (f)	Ancillary	MR(g)	Other (h)
Siemens Corporation		X	X				12	C	P	X		X		u
Space Age Computer Syst. Inc.	F		X	X	X		20*	C	X	X	P	X	X	a, d, i, p
Sperry Univac Corporation	1		X						X	X	X	X	X	a
Standard Systems, Inc.		X							X	X	X		X	
Systemedics Inc.	S	X	X				1200*	B	X	X			X	–
System Development Corp.	F		X				6*	A	X	X		X	X	a, i
Technicon Medical Infor. Sys.	F, 1, S		X	X	X		30*	C	X	X	P	X	X	a, i
Technicon T & T Corp.	1			X			100	C				X		
Telemed Corporation	S		X				1300*	C						e
TMS		X					4		X	X	P		X	
Tymshare Medical Systems	1, S		X	X	X		45*	B	X	X	X	X	X	a, d
Ultramation Inc.	F, 1, S	X					14*	B	X	X	P	X	X	e
Varian Data Machines	1		X				100*	C	X	X	X	X	X	
Wang Laboratories Inc.	1	X					250*	C	X	X	P	X	X	

patient billing, and insurance claims. Payroll, accounts payable, fixed assets management, and general ledger are not included as medical applications, since they do not relate to patients. "X" in a box indicates that the application is currently marketed. "P" indicates that it is planned for release within the next 12 months (after the time of response, typically Summer 1977).

(e) Management reporting and statistics: In most cases, these are produced as a byproduct of billing/accounting.

(f) Scheduling of patient appointments.

(g) Ancillary: Ancillary applications cover such departments as Laboratory, Pharmacy, and Radiology. The next column, MR (MEDICAL RECORDS) includes medical record summaries, histories, progress notes, medical and test data, orders, etc. Since ancillary results eventually become part of a medical record, the distinction is occasionally unclear. Some vendors may have included **Ancillary** in their response, even if this meant only the capture of charges from these departments for billing/accounting purposes. Vendors with more highly developed ancillary applications are noted under the EMPHASIS columns for LAB and PHARM. MR applications varied considerably in the amount of data gathered: from medical records *indexing* (i.e. patient identification, with almost no medical information), to *retrospective* medical abstracts of the PAS-MAP type, to records created and retrieved *concurrent* with a patient's stay or visit. In general, few vendors gave evidence of maintaining large portions of a patient's total medical record on computer.

(h) OTHER: The letters in this column refer to the following applications. The number of vendors naming each application is given in parentheses.

a – Admissions, discharge, transfer, census(38)
b – Blood Bank records (2)
c – Catheterization Lab (5)
d – Dietary planning (3)
e – EKG analysis (9)
f – Infection control (2)
g – Blood gas analysis (1)
h – Communications messages, paging (1)
i – Inventory, materials management(23)
k – Building environmental control (1)
l – Pulmonary function testing (4)
m – Physiological monitoring (4)
n – Nuclear Medicine (3)
p – Preventive maintenance (5)
r – Research (1)
s – Multiphasic screening (6)
t – Tumor registry (3)
u – Computerized tomography (2)
v – Left ventricular volume (1)
x – Radiation treatment planning (1)

X – Unspecified other, available
P – Unspecified other, planned

Note that since the survey was not designed specifically to capture data on these "other" applications, particularly highly specialized ones such as computerized tomography, it is likely that the results are less complete for these than for the applications in the previous five columns.

The table gives totals for each column for *all* vendors. When the vendors specializing in hospitals (i.e. not oriented toward clinics) are separated from the vendors specializing in clinics, the following differences are apparent:

1. Hospitals are more likely to use in-house implementations. Clinics are more likely to use service bureaus.

2. Hospitals place more emphasis on automating ancillary, medical records, and "other" applications; clinics place more emphasis on financial and managerial applications.

3. Vendors specializing in clinics average about twice as many clients as vendors specializing in hospitals.

Table 2 Vendor addresses, telephones, and contacts

Medical information system vendors:

ABACUS DATA SYSTEMS
P.O. Box 2121
Modesto, CA 95354
(209) 521-6287
K. Iwahashi, Owner

ABBOTT DIAGNOSTICS DIVISION
820 Mission
So. Pasadena, CA 91030
(213) 441-1171
M. MacGillivray, Product Manager

ACADEMY COMPUTING CORP.
2602 N.W. Expwy.
Suite 120
The Oil Center
Oklahoma City, OK 73112
(405) 840-2791
J. Sherburn, Ph.D., President

ACCUCOM DATA INC.
P.O. Box 2310
Napa, CA 94558
(707) 252-0866
D. M. Halcrow, President

ADP (AUTOMATIC DATA PROCESSING)
8760 Manchester
Brentwood, MO 63144
(314) 968-3000
L. Miner, Div. VP Sales

ADVANCED MEDICAL SYSTEMS
Div. of LHJ Systems Inc.
130 E. 59th Street
New York, NY 10022
(212) 486-2730
T. H. Ellson, Director Marketing

ALEX RIVERBANK ASSOCIATES LTD.
Medical Services Division
P.O. Box 324
Leola, PA 17540
(717) 299-1214
F. Frough, VP

ALL TYPE SYSTEMS INC.
7515 Pearl Road
Cleveland, OH 44130
(216) 234-6500
W. A. Weiland, Systems Analyst

AMES COLOR FILE CORP.
12 Park Street
Somerville, MA 02143
(617) 776-1142
S. Garelick, Communic. Mgr.

AML INTERNATIONAL
2721 N. Central Avenue
Suite 700
Phoenix, AZ 85004
(602) 263-6591
L. J. Baker, Communic, Dir.

ANALYTIC ASSOCIATES
P.O. Box 58251
Houston, TX 77058
(713) 481-9242
J. P. Smith, Pres.

APPALACHIAN COMPUTER SERVICES
P.O. Box 140
Highway 229
London, KY 40741
(606) 864-4151
D. Stivers, Dir. Cust. Svc.

ARTRONIX
1314 Hanley Indust. Ct.
St. Louis, MO 63144
(314) 968-4740
N. Smith, Mktg. Svcs. Mgr.

B-D ELECTRODYNE
Providence Highway,
Route 1
Sharon, MA 02067
(617) 828-9080
J. M. Arnold, Dir. Mktg. Supp. Oper.

B-D SPEAR MEDICAL SYSTEMS
123 Second Avenue
Waltham, MA 02154
(617) 890-4800
J. E. Stohlberg, Mgr. Sales Adm.

BAC-DATA MEDICAL INFORMATION SYSTEMS
120 Brighton Rd.
Clifton, NJ 07012
(201) 471-5242
V. J. Dedea, Sales Mgr.

BASIC/FOUR COMPUTER CORP.
18552 MacArthur Blvd.
Irvine, CA 92714
(714) 833-9350
G. B. Vincent, Indus. Mgr. Med.

BEEHIVE INT'L
4910 Amelia Earhart Drive
Salt Lake City, UT 84125
L. J. Nielson, Med. Syst. Manager

BIOMEDIMATION CORP.
200 West Monroe Street
Suite 1110
Chicago, IL 60606
(312) 782-2021
A. J. Perman, Director Marketing

BURLINGTON DATA PROCESSING
164 College Street
Burlington, VT 05401
(802) 658-2664
R. E. Tarrant, President

BURROUGHS CORP.
Burroughs Place
Detroit, MI 48232
(313) 972-7000
J. E. Robertson, Accounting Manager

BUSINESS INFORMATION SYSTEMS, INC.
One Davis Blvd.
Suite 509
Tampa, FL 33606
(813) 253-2796
M. L. Vierengel, Syst. Anal.

CCS (COMP. CONSULTING SERV. INC)
520 Dubuque Blvd.
Dubuque, IA 52001
(319) 556-3131
D. S. Mitchell, VP Mktg.

CDI (COMPUTER DYNAMICS INC.)
100 Hegenberger Rd.
Oakland, CA 94621
(415) 634-5800

CGR MEDICAL CORP.
2519 Wilkens Avenue
Baltimore, MD 21223
(301) 233-2300
G. A. Steer, Spec. Equip. Manager

CHART INC.
20 Computer Drive West
Albany, NY 12305
(518) 458-7666
S. Springer, Dir. Mktg.

CHC (COMMUNITY HEALTH COMPUTING)
4242 Southwest Freeway
Suite 504
Houston, TX 77027
(713) 960-1907
R. L. Craig, Head Tech. Marketing

Table 2. (Continued)

CLINIC SERVICES CORP.
300 E. Hampton, No. 222
Englewood, CO 80110
(303) 761-5080
J. D. Grow, Pres.

COMMERCIAL DATA SERVICES
2675 Cumberland Parkway
Suite 150
Atlanta, GA 30339
(404) 433-1429
W. D. Heisel, VP Sales

COMMERCIAL DATA SYSTEMS
Hartford Bldg., Suite 110
28 7315 Frontage Road
Shawnee Mission, KS 66204
(913) 384-4040
N. Norberg, VP Systems

COMPAS MEDICAL SYSTEMS INC.
P.O. Box 2208
San Antonio, TX 78298
(512) 924-4427
N. R. Tapp, Director Mktg. & Cons.

COMPUCARE, INC.
1970 Chain Bridge Rd.
Suite 602
McLean, VA 22101
(703) 821-8858
R. V. Aprahamian, Pres.

COMPUTER CONCEPTS & SERVICES INC.
P.O. Box 1082
St. Cloud, MN 56301
(612) 253-2170
D. Brennan, VP

COMPUTER LABORATORY SERVICES
P.O. Box 6293
Dallas, TX 75222
(214) 358-3631
C. McLeon, Pres.

COMPUTER MEDICAL CORP.
North 1430 Washington
Spokane, WA 99201
(509) 326-4220
S. T. Hatch, VP

COMPUTER SCIENCES CORP.
650 N. Sepulveda Blvd.
El Segundo, CA 90045
(213) 678-0311
A. H. Olson, Director HD Info. Svcs.

COMPUTER SYNERGY
1939 Harrison St.
Suite 202
Oakland, CA 94612
(415) 444-3434
T. J. Culligan, Pres.

COULTER ELECTRONICS
590 West 20th Street
Hialeah, FL 33010
(800) 327-6531
N. C. Honey, Comp. Grp. Sales Manager

CREATIVE SOCIO-MEDICS
Advanced Computer Techniques
437 Madison Avenue
New York, NY 10022
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EDELMAN SYSTEMS INC.
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HEWLETT-PACKARD CO.
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HOSPITAL COMPUTER SYSTEMS INC.
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INFORMATICS, INC.
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INTELLECTRON INT'L INC.
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INTERACTIVE SYSTEMS & MGT. CORPORATION
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Assessing acquisition alternatives

Chapter 6

Introduction

The previous chapter described the various departmental and hospital-wide medical information systems that might be considered by the hospital. Equal importance must be given to the manner in which the selected system is acquired. A limited system functioning as advertised can be useful. Even the best system, if it is not effectively implemented, can be a disaster. And disasters have not infrequently occurred. Almost everyone familiar with this field can recount one or more circumstances in which hundreds of thousands, or even millions of dollars, were expended on a system which never achieved operational status. Many more hospitals limp along realizing only a small portion of the potential capability of their systems because of poor execution. The technical difficulty in designing, developing and implementing an effective computer-communication system for the hospital environment should not be underestimated. Therefore, it is important to pay special attention to identification of risks and who will bear those risks. Too often the patient constituency or third-party constituency of a hospital is left "holding the bag" for enormous and on-going costs without any significant offsetting benefits. Therefore, the question of assessing the risks associated with a proposed system acquisition should receive considerable attention from the HSA reviewer.

"Do-it-yourself" systems development

To a hospital executive, perhaps the most obvious method of meeting the medical information system needs of the hospital is to purchase or lease a computer, hire a data processing manager and staff, ask each department to state their data processing requirements, prepare computer programs based on those requirements, and then place the system in operation. Several arguments are often advanced in favor of this approach. The first is that such an approach can be fully responsive to the unique requirements of the hospital in question. The needs of each department can be fully reflected in the design. Another argument is that this approach alone gives the hospital complete control over its data processing destiny. It is not forced to depend on outsiders or compromise its needs with the needs of other hospitals. Properly presented, these arguments can be, and often have been, persuasive.

Yet, the "do-it-yourself" approach has proven altogether too often to be fraught with difficulty. Even apparently simple and straight forward development objectives prove to be extremely complex. For example, nothing would seem to be simpler than automating the hospital payroll. Yet, when deduction requirements for federal, state and local governments are taken into account and combined with the fact that employees may live in multiple governmental jurisdictions, payroll withholding for a variety of fringe benefits must be considered, collective bargaining agreements may require complex record keeping concerning hours, vacations and holidays, and that all the foregoing is subject to almost constant change, some insight may be gained into the difficulty of the problem. It has been proven time and time again that development of a successful payroll program takes years to accomplish. Consider, then, a clinical laboratory system. Then consider further the requirements of a comprehensive hospital-wide system. The medical information systems which have been successfully developed thus far have all had development costs measured in many millions of dollars. Thus, the magnitude of investment is clearly beyond the resources of even the largest hospital.

Despite this rather negative outlook, numerous hospitals have at least begun "do-it-yourself" development. Often, this path was undertaken innocently, and even unintentionally. Traditional sales practice in the computer industry has been to identify single limited applications and sell only the equipment required for the initial application. The hospital then hires one or two people to develop and implement the application. Then a second application is suggested. The equipment is augmented, soon followed by augmentation of the staff. Not untypically, hospitals will discover they are expending half a million dollars or more per year for data processing, with relatively limited results and no clear understanding of how they arrived in this position. Even those hospitals who are in the minority among the "do-it-yourselfers" who have ultimately succeeded in developing a workable system have taken much longer and expended much more money than would otherwise be necessary. It is this author's judgment that the cost is typically tripled by this approach.

It is difficult to understand and explain the thinking that leads to supporting "do-it-yourself" computer system development. A hospital board would not for a moment think of undertaking development of the hospital's telephone system or elevator system or heating and air conditioning system. A medical information system is substantially more technically complex and costly than any of these other hospital systems. Yet, hospital boards continue to support, or at least passively acquiesce in plans for understanding medical information system development.

Proposals for "do-it-yourself" development will undoubtedly continue to be encountered. Three considerations are suggested as critical to the review process. First, considerable care should be given to reviewing the professional credentials of the data processing staff who will undertake the development. Their experience should include successful development of systems of similar purpose and magnitude. Prudence suggests that claims should be reinforced by reference checking.

Second, cost estimates and schedules should be supported by actual cost and schedule data from other hospitals' experience with comparable systems. It cannot be emphasized too strongly that errors in estimating of hundreds of percent are not uncommon in computer systems development.

Third, the HSA may wish to consider imposing a condition on any approval requiring the hospital to absorb costs beyond a certain level in excess of the estimated costs rather than merely passing these excess costs through to patients and third parties. Since these costs typically consist of salaries and equipment rentals, they would normally not be visible unless a special control is placed on them. HSA's may wish to also consider such conditions for other methods of system acquisition but it is suggested here because of the especially flagrant cost overruns that are commonplace in "do-it-yourself" development.

Packaged software

A variation on the "do-it-yourself" approach involves the acquisition of "packaged software," that is, computer programs previously developed elsewhere, requiring only "tailoring" and implementation to fit the hospital in question. There are two principal sources of packaged software. The first source are other hospitals who have developed the software for their own use. It is then "brokered" to other prospective users, typically by computer equipment manufacturers. Computer equipment sales are, of course, facilitated if claims of available software can be made. Any of the major computer equipment manufacturers thus has an inventory of computer programs for almost every hospital application, typically coming from as many hospitals.

While acquisition of software in this manner is less risky than development *de novo*, it is not without difficulties. Software developed by a hospital is invariably tailored to the idiosyncrasies of that hospital. Further, it may be expected to lack the flexibility necessary to be easily transferrable. This flexibility is achieved only when it is an original design objective, and it substantially increases the cost of design and sometimes operations. For example, a pharmacy system developed in a hospital with a single conventional pharmacy would require major modification to work in an institution committed to unit dose dispensing from decentralized satellite pharmacies. Similarly, a system that could handle up to 40 terminals would probably require major modification to handle 55 terminals. Since these packages are developed in a number of dissimilar hospitals, they cannot necessarily be expected to be compatible despite sales literature from a manufacturer showing them as an array of neatly drawn circles surrounding a central circle marked "hospital information system."

The second source of packaged software is the software company. Such a company is committed as

its primary business to the development of software packages. Since transferability and application to a variety of institutions is an objective underlying package development in such a firm, it is likely that such a package can be more easily tailored to the needs of the hospital. Also, the reputation of the software firm rests on the performance of its packages, whereas shortcomings in hospital developed packages can be blamed on the developing institution, and little blame accrues to the brokering equipment manufacturer.

Even well designed software packages must, however, be successfully implemented and operated. Further, the acquisition and interfacing of software packages is a difficult task which is rarely completely successful. Only when a system is developed as a coordinated, integrated whole may its individual component software parts be considered to be truly interfaceable. Therefore, considerations similar to those suggested for "do-it-yourself" development may be appropriate to the review process.

Vendor supplied and installed systems

Difficulty with the aforementioned approaches has led to increasing emphasis on acquisition of systems where not only the hardware and software is supplied by the vendor, but the vendor is also given the job of successfully installing the system. Results from this approach then depend on the excellence of the system in question and the performance of the vendor's staff. Experienced firms have emerged, particularly in clinical laboratory systems and level 1 medical information systems, who have compiled a credible performance record. Operations and maintenance remain the responsibility of the hospital.

For certain classes of systems with more limited functions, this approach has proven quite workable. Perhaps its principal limitation is that in its purest form it is static. The vendor comes in, installs the system and leaves. As the need for changes occur, the hospital is left to its own devices and rarely possesses the capability to make these changes. For that reason many hospitals prefer to establish a continuing relationship with the vendor.

Review considerations must concentrate on performance of the desired system in other hospitals and careful checking of the credentials of the vendor.

Vendor supplied, installed and operated systems

Transfer of responsibility to the vendor may, of course, be carried even further to include operations. This may take one of two forms—facilities management or external service. Under a facilities management agreement the vendor's staff carries out software and equipment maintenance and operations functions and may occupy the data processing facility in the hospital. These services may be provided on either a cost plus fee basis or a guaranteed fixed price basis.

Alternatively, the major computer equipment may be located in the vendor's own facility external to the hospital from which service is provided to the hospital via appropriate communication lines interconnected with hospital-based terminals and printers. The resident staff requirement is then minimized and certain economies of scale are achieved by the vendor. This approach, typically called the service approach, is widely used at both ends of the system spectrum. The most successful business office systems are provided in this manner from computer centers supporting hundreds of hospitals, and at the other extreme, sophisticated medical information systems are available on a service basis from vendor centers.

Under the service approach nearly all costs are rendered explicit, as they are now incurred by the vendor rather than by the hospital, and hence must appear in the vendor's charges. Comparisons will often suggest that an internal operation can perform the same functions at less expense. Careful analysis, however, may reveal that this apparent difference is attributable to implicit but ignored, costs. Internal costs which are often overlooked in economic analyses include floor space, utilities, equipment insurance, supplies, and fringe benefits. While clearly the vendor's purposes include achieving a profit, it is not likely that this profit level will offset the economies of shared operations and the additional experience and skill that the vendor can provide.

Here again, review should center on actual performance of the vendor's system and on the vendor's reputation.

Risks

It has been suggested in discussing the various alternative methods of system acquisition that substantial risks exist in implementing any medical infor-

mation system. Both the hospital and the HSA must be concerned with identifying these risks, and in particular, who will pay if events differ from expectations.

It is useful to think of these risks as falling into several categories. The first of these categories is whether the hospital is paying for *input* or for *output*. By *input* we mean the *ingredients* of a medical information system, computers, terminals, printers, systems analysts, programmers, supplies, utilities, etc. By *output* we mean the *results* of the medical information system—pay checks, patient bills, medication lists, laboratory reports, etc.

Perhaps our most serious reservation about the "do-it-yourself" or packaged software approaches are that they typically place the hospital in a contractual position of paying for input ingredients irrespective of whether the desired output results are obtained. In the "cost-plus" world of hospitals, this means that ultimately the hospital's patients and third-party payors must bear the financial consequences of the hospital's assumption of this risk. And, this risk is not merely theoretical. Hundreds of hospitals have found themselves committed to pay for equipment and staff salaries in amounts far in excess of the value received from the results obtained.

A significant improvement over an implicit or explicit agreement to pay for input ingredients is to pay a defined amount for a system after it is installed and accepted. Under this concept the risk remains with the vendor to fulfill the hospital's acceptance criteria. Further, the amount is fixed by contract and the variation in actual costs versus planned costs will result in profit or loss to the vendor and not to the hospital. The hospital risk begins only after acceptance.

Of course, on-going operational costs may increase in an unplanned manner following acceptance. Further, there is no assurance the system will continue to function and the hospital must continue to pay the on-going costs even when the system is out of service. This suggests an even more favorable risk allocation which is possible only under facility management or service agreements where the vendor assumes operational cost responsibility in addition to installation responsibility. This can typically be tied to a guaranteed level of operational performance so that the vendor, and not the hospital, carries the risk if the system is down or fails to meet other prescribed performance objectives.

From a public viewpoint this transfer of risk from the hospital, and hence ultimately from the public, to the vendor is highly desirable. Of course, a contract is ultimately only a license to go to court to seek relief, and the protection which it provides is no better than the financial resources of the vendor. Similarly, a contract highly favorable to the hospital does not make a poor system a good system. Therefore, review of medical information systems Certificate-of-Need Applications needs to be far more perceptive than simply an assessment of the placement of contractual risks. Nevertheless, such an assessment should be an important part of the review.

A second category of risk is financial responsibility for changes. It must be considered as inevitable that no medical information system will remain static in any hospital for an extended period of time. Changes will be inevitably required, either on a mandatory or optional basis. Mandatory changes typically follow from governmental actions such as changes in payroll withholding requirements, Medicare billing, dangerous drug reporting, PSRO controls, etc. When these changes are mandated by government, the hospital has little choice but to respond. When it is depending on an automated medical information system, this may well require a change in the system. A significant advantage of vendor supplied systems is that it has been the practice of vendors to modify their systems automatically to meet changed legislative and regulatory requirements, often without cost to their user hospitals. This specific point should be explored by the hospital with its prospective vendor and the result reflected in the contract.

The array of optional changes that might be desired by the hospital are, of course, endless. No vendor may be expected to automatically respond to the hospital's requests, and their response will almost invariably result in higher charges to the hospital. Many vendors, however, will review and classify requested changes, sometimes with the aid of users groups, and will use the result to guide their future development.

A third risk category that must be carefully considered is that associated with the consequences of hospital expansion and growth. This must be considered on at least a two dimensional basis. The first dimension is quantitative growth—that is, growth in beds, services, out patient visits, lab tests, etc. Any system has internal limits on the number of messages it can handle, the number of terminals it

can support, etc. While this will be discussed further in the next chapter, it is imperative that the vendor and the hospital explicitly identify the limits of possible growth with the intended system, along with associated costs of expansion and document their agreement in the system acquisition contract.

The second dimension of expansion and growth is qualitative; that is, to a progressively more comprehensive system. For a medical information system this may involve evolution from a level 1 system toward a level 3 system. It may be expected that any vendor will claim that his system is capable of such growth, and indeed, that he is working on developments which will result in such growth. The prudent hospital, however, will insist that this growth capability be firmly committed in the contract. Nothing will prove more expensive than to rely on the capability for such growth, and then discover it is necessary to throw out the system in question in order to progress to a higher level system. And, in general, technical considerations suggest such growth capability will not normally be present. Terminals which are suitable for level 1 use are simply not suitable for level 3 use. Storage and processing capabilities for level 1 systems will rarely support or be expandable to those required for level 2 or 3 operation.

Summing up

While the array of alternatives facing the hospital which must also be considered by the HSA reviewer may seem bewildering, a rather simple approach which should be useful to both the hospital on one hand and the HSA on the other can be suggested. A hospital should find a system meeting its requirements in actual operation in at least two hospitals. If the initially desired system is less than the system ultimately projected by the hospital in its hospital development plan, it should also see the desired system expanded to the projected level in actual operation in several hospitals.

Stated differently, nothing is accepted based on data processing staff or vendor claims or projections, but only on the basis of seeing the system in action. The prospective vendor's professional and business practice credentials are carefully checked with other client hospitals. Financial strength is verified through banking or other credit sources. The desired system is then acquired under a contract in which all risks of installation and operation are borne by the vendor, and the hospital's obligation is to pay a known fixed price for an operational system.

Such an approach may seem impossibly conservative, but it is the only one under which both the hospital and the HSA can have assurance that they have bounded the financial exposure of the hospital. Certainly any departure from this model should be done knowingly and explicitly so that the increased margin of risk can be carefully weighed against the presumed gain associated with accepting the risk.

To reiterate, the method of acquisition of a system compares in importance to the nature of the system being acquired. Fortunately, a sufficient body of experience exists to permit suggesting a reasonable approach to minimizing risk. This focus on risk may suggest a negative attitude—it is not intended. The author's plea is only for prudence.

Hospital development plan and system objectives

CHAPTER 7

Introduction

Among the criteria established by HEW, described in Chapter 2, is the relationship of the proposed medical information system acquisition to the long-range development plan of the hospital. In considering financial feasibility in Chapter 9, a lifetime of seven years (a rather arbitrary but apparently reasonable period) will be suggested for analysis purposes. It is important that some care be given to minimizing the possibility that the medical information system under consideration becomes obsolete in a shorter period.

Obsolescence frequently refers to the impact of new technology on old technology. Clearly, the medical information system field may be expected to evolve rather rapidly, reflecting continued progress in computers and electronics. Here, however, the reviewer need not be concerned with this kind of obsolescence. If a hospital procures a medical information system well suited to its needs, which saves more than it costs and fulfills this mission over a reasonable life, it may be quite satisfied. The possible availability of newer, better systems after such a procurement does not obviate a good decision nor affect the ability of the hospital to derive the benefits expected from that decision.

The hospital should be much more concerned about another kind of obsolescence—obsolescence in terms of the needs of the hospital. It cannot afford to acquire a system this year and discard it next year because it no longer meets its needs.

Of course, the future may be seen only imperfectly. Hence, such early obsolescence will occasionally occur. A significant responsibility exists, however, to endeavor to prevent this by careful consideration of possible changes that may reasonably be expected to occur over the projected lifetime of the proposed system. No project application should be considered to be complete without such consideration.

Ideally, much of this should be derivable from the hospital's long-range planning process which should exist independent from the question of acquisition of a medical information system. Whether or not this is the case, this chapter will outline the major planning considerations which are relevant to the specific decisions we are addressing.

Alternative futures

Assumptions about the future vitally affect hospital development plans. These assumptions tend to fall into three categories. It is often useful to test such a plan by considering what assumptions are implicit (or explicit) in its construction. Faulty planning usually stems from carelessness or poor judgment in the underlying assumptions rather than from errors in detailing the consequences of these assumptions.

The first category of assumptions is that the future will be just like the past. A system is then acquired to fit current needs. This planning assumption is usually implicit, and typically results from lack of thought about the future. Of course, the future may be just like the past but historical review usually demonstrates that this is a rather unusual occurrence. Despite this, it is probably the most common assumption made in project applications.

The second category of assumptions is that past *trends* will continue in the future. If admissions have been increasing at the rate of 10% per year, they will continue to so increase. If length of stay has been declining, it will continue to decline, etc. This kind of assumption is best tested against its context for consequences. For example, admissions forecasts should be tested against the demography

of the hospital's service area. Shifts in age distribution or population may render a simple trend projection invalid.

The third category of assumptions are those which project events that will make the future qualitatively different from the past. The hospital may discontinue its obstetrics department by transferring this role to another hospital. A major teaching affiliation may be established.

The administration, board and medical staff, need to identify such prospective qualitative changes as completely as possible and assign probabilities to both occurrence and timing. Then the potential impact on a medical information system acquisition can be considered through a series of "if—then" questions. A rather clear view of how this system would function or be modified to function under each significant eventuality should be established. If this is not possible because of the nature of the eventuality (e.g., "we merge with hospital A and consolidate facilities"), then serious consideration should be given to deferring the project if the eventuality is assigned a significant probability of occurrence.

System objectives

The hospital should establish for itself a rather clear view of its information automation objectives. This is likely to be a sequential migration toward a more comprehensive system. An example of such a view might be:

Year	Automation
1977	Patient billing and payroll
1979	Clinical laboratory; Accounts payable and inventory control
1980	Admitting—transfer—discharge and outpatient registration
1981	Level 3 medical information system

It should be noted that the so-called "modular approach," while intuitively appealing, exists more on paper than in reality. The number of incremental steps that can be taken are more limited than might be expected. The only safe approach to modular installation is to find a comprehensive system which functions satisfactorily and meets the hospital's ultimate needs and then explore the ways in which it can be economically broken into modules for modular implementation. The alternative approach, that of acquiring admissions system A, laboratory system B and nursing system C and assuming that they can be integrated is usually naive and rarely completely successful. The guiding rule which has been elaborated earlier, is that the prudent hospital will plan on *only* what it has seen in successful operation elsewhere.

Hospital needs

Hospital needs relevant to a medical information system should be derivable from the hospital's development plan. These include mission, relationships, physical plant and quantitative projections.

Mission

The hospital's mission(s) clearly affects system requirements. Information volumes are clearly different for short-term beds versus long-term beds. Outpatient care establishes unique requirements (long term active patient files) and impacts ancillary department information volumes. The nature of outpatient care provided is significant; ancillary outpatient services (e.g., laboratory and X-ray) are quite different than clinic care.

The prospective establishment of new, specialized services must be considered. Sameday surgery, dialysis, hospice care, mental health, radiation therapy are just a few examples of newer services which might be added.

Establishment of new teaching programs can impact system requirements. Clinical training of medical students may, for example, require the use of a level 3 system to write medical orders with the capability for review and release of these orders by a licensed physician before they may be acted upon. Additional terminals for teaching may often be required.

Research needs should be considered. Medical information systems may be useful for acquisition of data for clinical or hospital management research. Data needs must, however, be anticipated. These needs may affect system selection.

Relationships

Hospitals rarely exist without formal or informal relationships with other institutions. These include other hospitals, HMO's, teaching institutions and financial third parties.

Shared medical information systems have been found to offer certain advantages. While medical

information services may be provided from a shared computer facility by a vendor without requiring any special relationship between hospitals served from that facility, the possibility of a group of hospitals establishing a shared facility also exists.

The possibility of hospital merger must also be addressed by any long-range plan. This is an especially sensitive topic but medical information system planning can often take place on a "what if. . ." basis so that the system will not become obsolete whether or not a possible merger takes place.

Shared ancillary facilities represent another form of coordination of activity among hospitals short of merger. As laboratory equipment volume capability continues to grow and laboratory, radiology, and other clinical ancillary equipment escalates in cost, the attractiveness of sharing grows. Medical information systems can negate at least some of the limitations of such sharing by permitting communication of orders and reports at electronic speeds from remote sites.

Coordinated specialization may also enter its hospital plans. Increasingly, hospitals in a given area are limiting the number which provide such services as obstetrics, pediatrics and open heart surgery.

Teaching roles may not only affect this mission of the hospital and hence system content as discussed above, but may also affect system scope. It may be desirable, for example, to include terminals at a medical school tied into an affiliated teaching hospital. A similar consideration might lead to the desirability of locating terminals in a junior college with which the hospital may be affiliated for nursing training.

HMO's or other new organizational modalities should be considered. If it is likely that the hospital may become involved, then the implications for medical information system planning should be thought through.

Physical plant

Prospective changes in physical plant and equipment can, of course, affect information needs. Construction of a new hospital or major addition or rearrangements are obvious examples.

Opening of remote facilities for outpatient care, sameday surgery, etc., should also be considered. Existence of a comprehensive medical information system may, in fact, increase the feasibility of such plans by overcoming potential communication problems.

The possibility of introducing multiple facilities must also be considered for their impact. Nearly any hospital-wide information system can support a pharmacy but only the more sophisticated systems are designed to handle multiple pharmacies.

The introduction of other forms of automation is likely to affect medical information system planning. This is most prevalent in the clinical laboratory where most of the higher volume chemistry and hematology tests have been automated and where further automation is inevitable. The value of high speed automated equipment is in part offset if information to and from the equipment must be handled by conventional, rather slow, error-prone manual methods. Automation in other areas such as radiology and pharmacy, while less pervasive than in the clinical laboratory, should be anticipated.

Quantitative projections

After system objectives and hospital needs have been established and extensively reviewed by all major groups within the hospital, certain quantitative estimates should be made extending over a period corresponding to reasonable system life. The specific estimates required depend, of course, on the types of systems under consideration. A laboratory system will, for example, require estimates of projected volumes for each type, batteries, STAT orders, etc. Beds, inpatient days, average length of stay and outpatient visits are common estimates required for hospital-wide systems. System vendors will provide detailed lists of parameters which are required for sizing their system.

The critical issue in considering quantitative estimates is the consequence of making a major error. We noted early that misassessing the possibility of a major quantitative change was likely to be of most concern. Since no hospital can be expected to be omniscient, we must deal with the possibility of such an error by examining its consequences. This is done by *assuming* a large error and then determining the system consequences. This procedure is often referred to as sensitivity analysis.

The planner might ask, for example, what would be the consequence of census reaching 150% of estimate and length of stay reaching 150% of estimate. Since these errors would compound in affecting patient record storage requirements, the system would be required to store nearly 2.25 times the originally projected record volume. If the system design was such that its storage capacity could only be in-

creased by two times, prudence might lead to questioning that system as a candidate.

Maximum error will differ depending on the parameter under consideration. The maximum census error of 50% reflects the physical limitation of the hospital building. An outpatient visit estimate might, however, be subject to a 500% error over a seven year period because there may be no similar physical limitation.

Ideally, such an examination will lead to the conclusion that given the maximum errors in estimates (and combinations of estimates) the planner can foresee, the proposed system will be adequate, undoubtedly with modification. Or he may find a circumstance under which it would be inadequate. It then becomes necessary for the decision-maker or reviewer to elect or decline to assume the risk associated with this circumstance. The purpose of this procedure is to pinpoint the crucial issues.

Concluding note

The hospital development plan must be more than simply filling out a form. Rather, it must be a thinking process. It may be difficult for the reviewer to determine from the CON application how much thought has gone into the plan. This chapter has attempted to identify the more important issues. Interrogation of the hospital by reviewer about the issues should quickly establish whether the hospital itself has already identified and dealt with the appropriate questions.

No review procedure can eliminate future surprises. There is no reason, however, why the incidence of surprises can't be reduced and more importantly, their consequences largely mitigated by asking the right questions in advance.

Resource requirements

CHAPTER 8

Introduction

Chapter 2 noted that among the relevant criteria established by HEW is included:

> "The availability of resources (including health manpower, management personnel, and funds for capital and operating needs) and the availability of alternative uses for such resources."

Review of a medical information system Certificate-of-Need application should include such a consideration of such availability.

Financial and personnel resources must both be considered. Perhaps atypically, installation failures are almost invariably traceable to personnel limitations rather than to financial limitations.

Financial resource requirements

In Chapter 9, the cost elements making up a financial information system which must be financed will be identified in some detail. While such a system is properly considered a capital asset, most or all of these cost elements are typically treated as current *operating* expenditures and hence no capital financing issue is typically set forth in explicit form. Therefore, financing is, in fact, provided by patients and third parties. Despite the $1 million average project size, major appropriation from funded reserves or long term borrowings are rarely required.

The composition of system costs will, of course, vary significantly. A useful rule of thumb, however, is to consider that the computer facility, the terminals, and the personnel costs each represent a similar fraction (e.g., one-third) of total costs.

The computer industry has largely oriented its customers to two party leasing or rental; hence, capital costs are easily transformed into operating expenses. Moreover, an "open ended" relationship typically exists whereby the hospital can continually add equipment in small increments, each increment not infrequently falling below senior management or external HSA review cutoff levels. As equipment is added, requirements for additional staff are often generated.

It is not unusual for hospitals to discover they are expending a million dollars per year or more without any clear recollection of an explicit management decision to do so. In this, hospitals are not unlike private industry or other institutions. Indeed, an important dimension of growth of the computer industry in recent decades has been its ability to offer "painless" acquisition financing to its customers.

This unplanned growth is most common with "do-it-yourself" systems. Acquisition of a vendor-developed system presents a more explicit decision although lease financing is typically a part of such proposals.

Savings from third party leasing are likely to be most pronounced when widely used equipment is involved. The substantial resale market often leads leasing firms to accept greater risks than with less widely used equipment. Indeed, unique equipment can usually be leased only on the basis of a full pay-out financial lease which is little different in cost from that which would be associated with borrowing the full amount.

The CON should clearly set forth an analysis of the various financing alternatives considered and the rationale for the selected alternative. Reductions in monthly equipment costs of 5-30% may be achieved. While these reductions are not, strictly speaking, pure savings since increased risk assumption is typically involved (e.g., committing to a longer term), the favorable effect on hospital costs should not be ignored. Clearly, the hospital's chief financial officer should be involved. Assistance from

the hospital's banking officer or a board member who is a member of the financial community can often be helpful.

Therefore, while financing will rarely be a deterrant to the hospital or a limiting resource, its ready availability should not lead to the cost reduction potential associated with financing being ignored.

The hospital management should separate the question of system acquisition from the question of financing. While analysis may lead to the conclusion that financing offered by the preferred vendor may represent the most attractive alternative, this should not be assumed.

Sometimes financing charges are "bundled" with other services such as equipment maintenance, "free" software, etc. For proper analysis, it is essential to have the vendor "unbundle", that is, separately itemize charges.

While occasionally the hospital may have adequate cash reserves for a direct cash purchase, the most common alternative to vendor financing is third party lease financing. (We use "third party" here in its usual financial sense as referring to a financing source other than the vendor or the hospital; we are not referring to insurers of hospital patients.) Reduced monthly costs may be available from third party leasing firms for one or more of several reasons. First the leasing firm may use a longer lifetime estimate. Second, a higher residual value may be utilized. Third, a substantially lower interest rate may be used, particularly in so called "leveraged leasing" where the Investment Tax Credit and depreciation benefits are retained by the leasing company or its investors (although this is usually not possible for leases to non-profit institutions).

Personnel resources

The critical importance of adequate personnel resources as a determinant of success of a medical information system installation has been noted. Reviewers of proposed projects cannot be too sensitive to whether these resources are available and committed.

Management, technical, industrial engineering, nursing, department heads and medical staff all must be involved. We will consider each in turn.

Administration

The impact of a medical information system, particularly a comprehensive level 2 or level 3 system, cannot be overstated. Nearly every employee and medical staff member will be affected. Substantial organizational and procedural changes are often required to fully realize the benefits of the system. Probably no event, save moving the hospital to a new building, will affect as many people. And this impact will interact with many aspects of their jobs because of the central role of accessing, processing and storing information in most health care tasks.

Resistance to change of this magnitude is almost inevitable. Some are threatened while others are merely annoyed by introduction of such a system. Experience with both successful and unsuccessful installations has led to some guidelines that seem important. Successful installation of major systems are characterized by:

- Commitment and leadership by the chief executive officer, typically the administrator.
- Active participation in the decision-making process by each major employee and staff group.

Project review should include ascertaining whether these criteria have been fulfilled. If it appears that the thrust for the proposed system has come from the data processing or other lower management level without the participation and clear support of top management, or if key groups such as nursing, medical staff and the major department heads have not participated actively in the decision to acquire a comprehensive system, its installation is almost guaranteed to be traumatic.

This will lead to at least two adverse economic consequences. First, installation will tend to be delayed as disputes surface and resistance must be overcome. Since many installation costs are "period costs," that is, they increase with time (e.g., equipment rentals and installation staff salaries), schedule slippage will translate directly into increased installation costs. Second, benefit realization will be frustrated where there is failure to secure agreement on staff reductions.

The most straightforward way to avoid these difficulties is by top management leadership and participation. This principle can be applied by analogy to departmental systems. Clearly, it would be unwise to install a laboratory information system without clear commitment and leadership of the laboratory director or the participation of staff pathologists and senior technologists in the decision making and selection process.

Data processing

Installation of a medical information system almost by definition seems to call for the hospital to have data processing or computer people on its staff. Yet, there have been a number of successful installations of systems, including comprehensive level 3 systems, by hospitals with no data processing personnel!

These hospitals have successfully procured vendor developed systems, recognizing that the hospital's job was one of management, requirements definition, selection, economic analysis, training and benefits realization—not computer engineering or programming. They correctly identified the key tasks that must be reserved to the hospital and those which could and should be delegated to a responsible vendor for which he would be held contractually responsible.

Data processing personnel are required only if the hospital undertakes "do-it-yourself" development of a medical information system, whether from "scratch" or by modifying and assembling software packages developed at other institutions. The exceptional risks associated with such courses of action have been suggested elsewhere. Expenditure levels can quickly rise to millions of dollars per year and months stretch into years with little in the way of a useful operational system functioning.

The requirements for development of a medical information system are beyond the purpose and scope of this book. The author has seen only a handful of hospitals in the U.S. with data processing staffs even remotely approaching the capability level required for level 2 or level 3 system development. In the event a project review is required of such a proposed development, it may be desirable for the reviewer to retain a consultant with direct technical management experience in the previous successful development of a comparable system to review the development plan, budget, schedule and associated data processing personnel qualifications.

Industrial engineering

Industrial engineering (or hospital management engineering) is a desirable capability in any hospital and almost essential in the successful installation of a larger medical information system. Hospitals without this capability are urged to acquire it as a prerequisite to embarking on a medical information system acquisition program.

Industrial engineers are trained to perform both the economic projection and benefit realization studies which we will describe in Chapter 9. To take full advantage of medical information systems, substantial methods of revision and organizational realignment must be made. While line supervision must take ultimate responsibility for such changes, industrial engineers are trained to provide the specialized analysis leading to increased operating effectiveness and lower unit costs. This capability is especially important in working across departmental lines in eliminating duplication and improving coordination.

At least one industrial engineer should be assigned to a major medical information system project throughout the decision making, implementation and benefit realization period. For all purposes, industrial engineering staffing at the ratio of one per 150 beds seems reasonable. If care is taken to employ industrial engineers with first rank training and ability, their cost should be returned many-fold to the hospital and the community through the savings they will create.

Nursing

Any comprehensive system which a hospital may install will impact nursing more than any other department. Nursing department personnel comprise the largest group within the hospital workforce. Nursing is at the locus of patient care where nearly all medical orders originate and end. Personnel savings and benefits for a level 2 or level 3 system are likely to be greatest in nursing. Nurses have been found to play a key role in assisting physicians in the use of and shaping physician attitudes toward medical information systems, particularly level 3.

For all of these reasons, it is essential that key nursing personnel be involved in all phases of planning, acquisition and implementation of a medical information system. Ideally, nurses will have visited hospitals and used candidate systems for a day or two actually assisting in patient care delivery. Nursing personnel should be assigned full-time to the implementation team and other nurses should be full-time members of benefit realization teams with industrial engineers. Nursing indoctrination and in-service training should be revised to include use of the medical information system.

Department heads

The major department heads also play a critical role in selection, implementation and benefit realization. Apart from nursing which was discussed

separately, involvement of the heads of pathology, radiology and pharmacy are especially important.

A major portion of the information traffic of the hospital flows between these departments and the nursing stations or outpatient departments. The system may automate, and hence revise, many functions internal to these departments. Questions of interfacing the medical information system with departmental systems may arise. Major organizational options may be created such as converting the pharmacy from conventional to unit dose dispensing. The professional relationship between these departments and attending physicians or house staff means that the attitudes of the latter groups toward medical information systems are often shaped by the major ancillary departments. Blaming late lab reports, wrong medications or fouled up radiology schedules on the system almost assures enmity from the affected physician.

Other department heads should not be ignored. The controller and business office manager must have confidence in automated charge collection through the system. Food service, physical medicine, EKG, outpatient clinics, housekeeping, engineering – all are affected and should be frequently consulted. The impact, however, on these departments is typically not as great as on pathology, radiology or pharmacy.

Medical staff

A hospital is a place where doctors take care of patients! The myriad services and resources of the hospital exist to respond to the physician's orders. Most information flow in a hospital results from a physician's order and ends with information transmitted back to the physician or action taken with the physician's patient.

The foregoing seems so obvious that it is almost insulting to the reader's intelligence. Yet many information systems are designed which carefully avoid any interface with the physician whatsoever. Many systems are selected and installed with no consultation or participation by the medical staff.

This issue has been considered earlier is describing the various system levels. It is reintroduced here to suggest that the implementation of *any* system in the hospital should have the involvement and support of the medical staff because it is difficult to change information flow anywhere in the hospital beyond the most trivial level without affecting physicians. Installation of a laboratory information system may seem wholly the business of the clinical laboratory but confronting the medical staff with reformatted, computer printed laboratory reports is almost certain to be resented if the report users were not consulted in advance.

Failure to involve medical staff seems to stem from the uneasy relationships which exist in too many hospitals. Administration regards the medical staff as a "sleeping giant" which must not be aroused. Hence, actions are taken quietly with the view that tip toeing around will avoid waking the giant!

Conversely, in these hospitals the medical staffs not infrequently regard administrators as "hired lackeys" whose job is to do what they are told (by the doctors) and not "make waves"! Introduction of a medical information system is bound to upset this uneasy relationship.

Fortunately, there are an increasing number of hospitals where administration and medical staff recognize their interdependence and the need for continuing participation and consultation on all significant decisions. It would not even occur to the administration of such a hospital to select and install a medical information system without the active participation and support of the medical staff.

Not only will this cooperative relationship minimize the trauma associated with a major change in the way the hospital operates, it will insure that the judgment and perspective of physicians goes into key decisions. This is especially crucial if the groundwork is to be successfully laid for installation at some point of a level 3 system.

Concluding comment

This chapter has discussed at some length the importance of involvement by various affected groups as essential resources which the project reviewer must consider. It may be difficult to comprehend why such a "soft" resource is so vital to accomplishing what is often perceived as a purely technical task – that of installing a computer-communication system.

The reviewer must be aware, however, that experience in this field has demonstrated that success or failure of medical information systems typically depends on cooperation and support or resistance and rejection. Technical considerations are indirect; that is, a poorly designed system may be difficult to use, too slow or unreliable. Disaster occurs, however, when users give up an[illegible] their

cooperation. Any system installation will encounter difficulties. Therefore, it is essential that an adequate reserve of "cooperation capital" be created by openness, participation and consultation with all involved from the very outset.

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Financial feasibility and economic impact

CHAPTER 9

Introduction

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Recently, the Upper Peninsula Health Systems Agency polled 969 residents of Michigan's upper peninsula and asked them to rank 40 health care problems. Health care cost was ranked as the number one problem—ahead of cancer, heart disease, family physicians, Medicare/Medicaid acceptance and everything else.[1] There is no reason to believe that these upper mid-westerners feel any more strongly about health care costs than Americans elsewhere.

This chapter will consider the economic feasibility of Certificate-of-Need applications for medical information systems. The HEW-mandated criterion is:

> "The immediate and long-term financial feasibility of the proposal, as well as the probable impact on the costs and charges for providing health services by the hospital."

Sharing the concern over cost of the people of the Upper Peninsula, this author's bias is toward the viewpoint that if a medical information system does not pay for itself, it should not be installed. This bias goes beyond the HEW criteria; therefore, this chapter will present a methodology for analysis and leave the ultimate decision making to the hospital and the HSA.

Approach

Financial analysis awes many people. Indeed, the typical CON application is filled with pages of numbers—the reader is instinctively propelled toward finding a summary page which invariably shows a summary of costs and savings, the latter exceeding the former. The reader rarely has the confidence or inclination to analyze the numbers, and perhaps more important, identify the usually unstated assumptions behind the numbers and consider their validity.

Unfortunately, the consequences of this aversion to financial analysis is that many—indeed most—CON's are "rubber stamped" without critical analysis of their financial impact. The purpose here will be to suggest a method of analysis which will permit realistic review of proposed medical information system projects.

The method will be to consider three variables—total costs, total realizable savings and time. The definition of total costs is quite straightforward—total costs are the sum of checks written to employees or vendors that would not have been written had the project not been undertaken. Note that the definition included, "the *sum* of the checks," not "some of the checks." Identifying *all* of the costs is important.

The definition of total realizable savings is similar—the sum of checks not written to employees or vendors plus beneficial increases in hospital revenue attributable to the project.

The definition of total realizable savings requires more comment. Note that no reference was made to "increased efficiency," "higher productivity," etc. There is nothing wrong with increased efficiency and higher productivity and similar phrases. It is important to *count*, however, only the *results* and *the results must show up in the hospital's bank balance or be ignored*. The emphasis on the *hospital's* bank balance and not on the costs of individual departments is not accidental. Not infrequently, medical information systems will reduce costs in one department by shifting them to another department, or creating a new task elsewhere in the hospital.

Total realizable savings also includes "beneficial increases in hospital revenue." Here the key word is *beneficial*, judged from the perspective of the community the hospital serves. Evaluation research has

[1] *What in Health is Happening*, Vol III, No. 9, Upper Peninsula Health Systems Agency, Inc., May, 1979.

shown that a level 3 medical information system will reduce average length of patient stay due to greatly decreased response time to medical orders. Since revenue is highest on the first day of stay and falls thereafter, a length of stay reduction will result in higher hospital revenue (assuming admissions increase to keep occupancy consistent). This is beneficial to the community because the "throughput" of the hospital is now increased.

Conversely, consider the often claimed benefit of increased hospital revenue from capture of lost ancillary charges. Undoubtedly, many "charge tickets" are lost in manual systems and a medical information system will eliminate this as charging is concommitant with ordering. Estimates of lost charges equalling 2 to 5% of hospital revenues are typical.

Increased revenue from capturing lost charges is not beneficial to the community and hence should *not* be counted as a saving. The rationale for this position was outlined in Chapter 3.

Time is the third important variable because of the time value of money. A dollar of saving this year is worth more than a dollar of saving five years from now. Therefore, it is necessary to consider not only *how much*, but also *when* in considering costs and savings.

The recommended approach then is to compare the time-based stream of costs with the stream of savings by one of two methods. The first method calls for the calculation of the interest rate which causes the two streams to be discounted back to the same present value. This interest rate is known as the *discounted cash flow return on investment* (DCF-ROI) or *internal rate of return* (IRR).

Under the second method, a realistic interest rate, say 10%, is assumed and applied to the net stream, discounting it back to *net present value* where it may be compared with the initial cost. Both methods are described in more detail in any financial calculator instruction book.

Since total costs may exceed total savings, the second method is often more appropriate. The *net present value* (or *net present cost*) is the measure in current dollars of the financial benefit or penalty associated with implementating the project. If this figure is negative, that is, the project has a net present cost, then decision makers must carefully consider whether the *non*-financial benefits (more timely results, legible records, complete orders, decreased patient waiting, shared access to records throughout the hospital, fewer lost or duplicate orders, more accurate results, better management data, improved resource utilization, etc.) are sufficient to justify the increased cost.

Some definitions

It is useful to differentiate between *potential savings*, *realizable savings* and *realized savings*. From a different perspective, we can divide savings between *labor savings* and *non-labor savings*. It is also useful to distinguish between *cost reduction* and *cost avoidance*.

Keep in mind that medical information systems save work while hospital managers must translate this saved work into saved money (by writing fewer checks!). Suppose, for example, that a system automatically compiles and prints the midnight census, a task that formerly required four hours per night by a clerk in the Nursing Office. The saved four hours are identified as *potential savings*. Assuming a part-time employee is impractical, the question becomes whether a strategy can be found to combine this four hour saving (0.5 FTE) with another four hour savings so that an employee can be removed from the payroll. (Remember, don't count the saving until the paycheck is no longer being written.) If such a strategy exists, then this four hour saving is a *realizable saving*. If not, we must concede that it is *unrealizable* and ignore it for financial analysis purposes (although the hospital will strive to put the four hours to good use on new tasks). *After* (and only after) the person is removed from the payroll, the four hour savings will be described as a *realized saving*.

Note that *analysis* (estimating that four hours were required to prepare the census), *planning* (finding another four hour saving that could be consolidated), and *management action* (eliminating the employee from the payroll) were all required to achieve a *realized saving*. The CON reviewer must be satisfied that all three ingredients are present before savings may confidently be expected.

The most critical element of realization is management commitment to take the necessary action. This is particularly so with labor savings which usually require staff reductions. A sound CON application should contain a list of clearly identified positions to be eliminated, the dates for elimination, and the signatures of the cognizant department managers commiting to make the staff reductions. Experience has suggested in the absence of

such an explicit commitment by the person(s) with direct authority and responsibility, that the reduction gets deferred and often never made.

This example of census preparation illustrates *cost reduction*. Suppose that external reporting requirements were pending that would expand the detail required in the census and hence expand the time required for manual preparation from four hours to six hours. Eliminating this two hour increase with the system would be called *cost avoidance*. This is perfectly legitimate; however, common sense suggests that spending money to save money not yet being spent deserves a little extra scrutiny to assure validity.

Identifying total costs

With an analytical approach and some definitions in mind, the discussion will now turn toward a realistic assessment methodology. The hospital should begin by considering project costs.

A particularly commonplace deficiency in medical information system CON's is failure to consider all elements of cost. While due in some cases to oversight, it is likely that this deficiency is exacerbated by the view that CON review applies only to *capital* costs and not *operating* costs. Yet, it seems clear that if the hospital considers *decreases* in operating costs in its analysis as benefits, it must correspondingly consider *increases* in operating costs as well.

To assist in identifying total costs, Table 9-1 presents a cost checklist. Not every cost element in Table 9-1 will be present in every project; similarly, this table is not necessarily exhaustive, a cost element not listed might be present in a given project.

In projecting the magnitude of a given cost element, the *marginal* or additional cost should be used, not the average or allocated cost. For example, only the *increase* in the hospital's electric bill should be used, not the average cost per kwh. Remember, the definition of total costs are checks which would not be written by the hospital if the project were not undertaken.

Next to omission of cost elements, the next common error in projecting costs is failure to establish a realistic installation and "shakedown" schedule. Many project-related costs are "period costs"; that is, they continue at a certain rate per month once they are started like a running faucet. Equipment rental and data processing personnel salaries are

Table 9-1 Cost checklist

1.0 *Equipment*
- 1.1 Computers and peripherals
- 1.2 Terminals and printers
- 1.3 Communications
- 1.4 Interface devices
- 1.5 Shipping
- 1.6 Storage racks

2.0 *Facilities*
- 2.1 Floor space
- 2.2 Site preparation
- 2.3 Air conditioning
- 2.4 Electrical
- 2.5 Cabling
- 2.6 Sub-flooring
- 2.7 Controls, monitors, alarms

3.0 *Software*
- 3.1 Operating systems
  - 3.11 Rental
  - 3.12 Development/conversion
  - 3.13 Maintenance
- 3.2 Application programs
  - 3.21 Rental
  - 3.22 Developmental/conversion
  - 3.23 Maintenance

4.0 *Maintenance* (labor, equipment, parts and supplies)
- 4.1 Computers and peripherals
- 4.2 Terminals and printers
- 4.3 Communication equipment
- 4.4 Facilities (air conditioning, etc.)

5.0 *Utilities* (installation and usage)
- 5.1 Electrical
- 5.2 Telephone
- 5.3 Air conditioning

6.0 *Taxes and Insurance*
- 6.1 Sales tax
- 6.2 Property tax
- 6.3 Casualty insurance

7.0 *Training*
- 7.1 Initial training and installation support
- 7.2 Inservice training
- 7.3 Documentation

8.0 *Supplies*
- 8.1 Tapes and disks
- 8.2 Printer paper/ribbons
- 8.3 Forms and labels
- 8.4 Punched cards

9.0 *Management*
- 9.1 Hospital
- 9.2 Facilities management
- 9.3 Consultants

10.0 *Industrial Engineering*
- 10.1 Implementation
- 10.2 Benefit realization

11.0 *Labor Fringe Benefits*
- 11.1 Group insurance
- 11.2 Retirement
- 11.3 Payroll taxes
- 11.4 Vacation and holidays

just two examples. If a planned six month installation schedule turns into twelve months in practice, these period installation costs will be doubled.

The best protection against schedule error is to survey several hospitals who have previously installed the system of interest. A realistic installation schedule should emerge from such a survey.

Implicit in this suggestion is installation of a vendor-provided system. Schedule missestimates are both commonplace and of a magnitude not infrequently approaching disaster with "do-it-yourself" systems development. While hospital management can control the *rate* of expenditures by limiting their approval of equipment rental or data processing hiring, a one-year development and installation schedule can turn into a three-year schedule thereby tripling costs.

The adverse impact of schedule slippage is double-barreled. Not only do installation costs escalate but realizable cost savings are deferred. Because of the time value of money discussed earlier, the value of deferred savings is diminished. In addition to these financial consequences, credibility and motivation may also be lost.

Thus, the importance of a *realistic* installation schedule cannot be over emphasized. If all elements of costs are considered and a schedule consistent with the actual experience of other hospitals is employed, a good assessment of total costs should result. Errors in estimating individual cost elements will be made but they are likely to largely cancel each other out unless systematic bias is present. Such bias might result if all estimates were made by a strong project advocate. Assurance that the estimates were made by or reviewed by the hospital controller or some other independent agency is therefore prudent.

Identifying total benefits

Having identified a time-phased estimate of total project costs, the hospital must now similarly identify project financial benefits. Table 9-2, Benefits Checklist, is useful for that purpose. Some of these benefits require discussion.

Realizable Labor Savings will represent as much as 80% of the benefits of level 3 systems. Detailed procedures for estimating them require industrial engineering or hospital management engineering skills; however, the approach is conceptually quite straightforward.

Table 9-2 Benefits checklist

1.0 *Realizable Labor Savings*
- 1.1 Labor
- 1.2 Fringe benefits
- 1.3 Supervision and management

2.0 *Consumables*
- 2.1 Forms
- 2.2 Medications and supplies
- 2.3 Meals

3.0 *Previous System Costs*
- 3.1 Labor and fringe benefits
- 3.2 Equipment and maintenance
- 3.3 Supplies
- 3.4 Services

4.0 *Interest Costs*
- 4.1 Accelerated billing
- 4.2 Reduced receivables aging
- 4.3 More accurate third party claims

5.0 *Capital Facility Costs*
- 5.1 Reduced length of stay
- 5.2 Improved scheduling
- 5.3 Shared facilities

- Identify each hospital function affected by the system (e.g., "admit a patient").
- Flow chart each function using pre-system manual procedures and again, using post-system automated procedures.
- Assign standard times to each element by skill category in each flow chart.
- Subtract the times with the automated procedure from those with the manual procedure.
- Estimate the frequency each function will be performed (e.g., "admissions per month").
- Estimate the cost of labor involved (e.g., "admitting clerk monthly wage and fringe").
- Examine fractional savings in a given department (e.g., "Admitting") resulting from different functions and establish a strategy for consolidating these fractional savings into full time positions which can be eliminated (realizable benefits).
- Establish a time phased schedule of positions to be eliminated, identifying *specific positions*.
- Secure written concurrence of the affected manager (e.g., "Admitting Manager") and the hospital administrator.
- Convert eliminated positions into realizable dollar savings by applying the cost of labor to each identified position and aggregating by month.

There are many behavioral considerations affecting this process which are beyond our immediate

purpose to discuss. The reviewer must make a judgment, however, about the likelihood that the hospital will, indeed, realize the labor savings projected. Except in a rapidly growing hospital, *this means people leaving the payroll.*

In the *Supplies* category, manual forms are, of course, eliminated. Many patient oriented supplies might be saved. For example, a level 2 or 3 system with unit dose pharmacy capability might eliminate significant waste of unused medications dispensed but not administered under a conventional hospital pharmacy/medical system. While typically the hospital would have charged for these wasted medications upon dispensing from the pharmacy, and so no financial loss was incurred by the hospital, patients (and third parties) will directly benefit financially from eliminating this waste. Many other similar categories such as meals can be identified.

Hospital interest costs may be reduced in at least two ways. First, hospitals typically wait three or four days after patient discharge before submitting a final bill to permit charge tickets to arrive from ancillary departments. Automated systems typically permit reducing this cut off period to one or two days (long term tests, e.g., cultures, make it difficult to completely eliminate the cut off period). The hospital's cash flow is moved up by this time and this one time cash gain results in reducing interest costs.

Similarly, better collection procedures and more accurate, detailed billings reducing queries from third parties can reduce average receivable aging. Again, an interest saving will result.

Capital cost avoidance may also occur. We have already noted that a level 3 system may reduce average patient length of stay. If the resultant increase in patient throughput permits the hospital to postpone or avoid construction of additional beds, a savings of perhaps $80,000 per bed might result. The interest on such saved capital funds can be attributed to the system.

Improved scheduling by automated methods, say in radiology, may improve utilization of expensive radiology equipment and thereby eliminate the need for acquiring additional equipment.

Several departments within a hospital or, indeed, several hospitals may find ways to share expensive capital equipment or facilities which becomes practical with the near-instantaneous communications capability of a medical information system. Again, the interest value on the saved capital investment should properly be counted as a cost saving.

Some key assumptions

In order to relate the cost and savings and arrive at a return on investment or net present value, certain assumptions must be made. Often these assumptions are never stated; they are merely implicit in the CON financial analysis. Yet, these assumptions often are more important in affecting the result than the cost or saving estimates themselves. Therefore, the CON reviewer should render these assumptions explicit and consider their reasonableness. The principal assumptions that should be identified are useful life, inflation rate, installation schedule, benefit realization schedule, financing method and risk.

Medical information system equipment—computers, peripherals and terminals—has an almost indefinite physical life if properly maintained. The rapid pace of technological development does, however, result in a rather high rate of obsolescence and perhaps results in decreased vendor support and availability of required maintenance skills and components. Establishing a *useful life* is necessarily arbitrary. Experience suggests, however, that in the absence of a well-reasoned argument for another period, a useful life of seven years with no salvage value is reasonable.

Inflation has become a major factor in our economy. Medical information systems represent a potential inflation fighting tool as future costs subject to inflation, particularly labor costs, can be replaced by a present fixed cost. Unfortunately, this may be offset by higher interest rates for system financing (historically, "no risk" interest rates are approximately 2 to 3% plus the inflation rate). Nevertheless, estimates of future costs and savings should be adjusted for inflation.

Inflation rates may differ for various cost and savings elements. Equipment maintenance may, for example, be fixed by contract with the vendor over a specified period. Labor costs may be governed for a period by a collective bargaining agreement. In the absence of specific guides, a reasonable approach is to use the return on government bonds with a maturity comparable to useful system life less 2 to 3%. Thus, if government bonds with a maturity seven years hence are yielding 10½%, an inflation rate of 7½% to 8½% is implicit in this yield reflecting the market judgment. An inflation rate of 8% would be reasonable for analytical purposes based on this example.

Earlier in this chapter the importance of establishing a realistic *installation schedule* was discussed. It is reiterated that the best test is to consider the actual experience of other hospitals in installing the same system. The installation schedule should be supported by such data; it should not merely reflect the vendor's estimate which may tend to be optimistic.

Similarly, a *benefit realization schedule* must be carefully established. Many CON applications show projected savings commencing immediately. No savings can occur until after installation is complete. Then, a finite period is usually required before all savings can be realized. A level 1 system might require three months to install, three months to "shakedown" and six months to realize savings' hence, an assumption that savings begin in the second year might be realistic. A level 3 system might require 12 months to install, six months to "shakedown" and six months to realize savings so that savings might not begin until the third year. These are generalizations which should be replaced by a reasoned analysis in a specific case under review. Rarely, however, can savings be assumed to start instantly.

Financing methods tend to confuse an analysis but also represent an opportunity for substantial savings. Conceptually, any financing should be "backed out" of the cost stream. For example, if equipment costing $1 million is acquired on a five year financial lease (in contrast to a true lease), our analysis would show $1 million cost in the first year, not $22,000 per month for the first 60 months.

Under the return on investment analysis method, investment theory calls for comparison of the rates of return with the average cost of capital to the hospital. From a purely financial viewpoint, if the project has a return of 12% and the hospital's average current borrowing costs (weighted average of bonds, bank loans, etc.) is 10%, then the project is *financially* justified. (In practice, of course, the CON review will lead to a judgment on a broader basis.) If the hospital can finance the project from existing funds, the cost of capital should not be considered to be zero, but rather should be set at a level approximating the "opportunity cost" of those funds, that is, the foregone investment returns which might be a bank certificate of deposit rate of, say 10%.

Computer equipment vendors typically offer lease or installment purchase financing for their equipment. This should not automatically be accepted, however. While a detailed exposition of financing is beyond the purpose here, the following alternatives should be considered:

1. Use of hospital funds.
2. Third party leasing, particularly where widely used computer equipment is involved.
3. Bank borrowing using the general credit of the hospital.

As any experienced financial officer is aware, careful analysis of financing alternatives can produce major savings (or avoid major unnecessary costs).

Finally, no financial analysis is complete without consideration of *risk* (the "downside" in financial jargon). Risk is simply the possibility that actual results might differ from projected results. Although it cannot be documented, perhaps half the computer projects in American hospitals have failed to produce projected financial benefits. Yet, a review of more than 50 medical information system CON applications failed to reveal a single instance of risk assessment!

Risk assessment can be most easily performed by first identifying the variables most subject to errors in projection, establishing a "worse case" estimate for each such variable, and then examining the impact of each "worse case" on the overall result, both singly and in combination. Typically, the installation schedule, the benefits realization schedule and labor savings are the three variables most subject to projection error. A simple "worst case" analysis might examine the impact of doubling the two schedule periods and halving the projected labor saving.

Risk analysis is particularly important in "do-it-yourself" projects. Not infrequently, hospitals who have undertaken *de novo* development or even "tailoring" of software packages have seen years go by with the "meter running"—data processing salaries and equipment rentals paid—with little or no benefit. Just as no physician would consider undertaking a course of treatment without carefully considering the possibility and extent of adverse results, no responsible hospital should commit itself to a major medical information system project without risk assessment.

Assessing risk does not, of course, eliminate it; it merely renders it explicit in the decision-making process. The only way to reduce risk is to emulate success; that is, find and follow a course of action which has been followed by other hospitals under similar circumstances with demonstrable success.

A case study

It is useful to examine how the concepts set forth in this chapter might be used in an actual review. Data will be taken from an actual review. For this purpose, a rather complete application for a system known to perform well has been selected. Since the purpose is not to criticize any particular hospital or HSA, the hospital, system and HSA will not be identified, even though the application is a public document.

The hospital's "Cost Justification Analysis" is reproduced in Figure 9-1. The analysis will be based on these data, bringing in other data from the application or making assumptions where no data is provided.

Initially, it may be noted that savings exceed costs in every year—the return on investment is infinite! Similarly, if a target return of 10% is used, calculation from the seven year stream of "total cost less savings" results in a present value of $432,014. Since there is no initial cost, this investment exceeds the 10% investment criteria (or any other rate we might have set). Indeed, if enough investment opportunities like this were available to the hospital, patients would no longer have to be charged for health care!

To begin a critical analysis, it is first necessary to make explicit the key assumptions:

- Useful life—seven years is used in Figure 9-1 and it is agreed that this is reasonable.
- Inflation rate—6% is assumed in note #1 in Figure 9-1. This seems somewhat low but it will be accepted. Other rates are used in notes #2, #3 and #4.
- Installation Schedule—The application indicates five months from start to equipment installation and four more months to "bring up" the system throughout the hospital.
- Benefit Realization Schedule—None is stated although Figure 9-1 suggests benefits are realized simultaneously with installation. It will be assumed to require three months after completion of installation. Thus, benefits will commence in the second year (nine months installation plus three month benefit realization periods).
- Financing Method—The application suggests "software and hardware" and "installation" are funded by the vendor over the seven year period at a rate in excess of the hospital's local bank credit lines. An informed "guess" is that the hospital's local rate is one point over prime and financing rate is three points over prime. Since the prime was 10% at the time of this application, it is reasonable to assume 11% and 13% respectively.

The method calls for separating out the effect of financing so the financing of "software and hardware" are "backed out" at 13%, leading to a calculation of the purchase cost of $732,628. Similarly, the "installation costs" are $43,028.

Now, it is necessary to consider any omitted installation costs. In the absence of specific information, the following informed "guesses" will be made using Table 9-1 as a checklist:

Equipment Shipping	$ 1,500
Site Preparation	12,000
Electrical	5,000
Cabling	7,000
Applications development (data tables), (2 man-years @$15,000/m-y, plus 25% fringe)	37,500
Electrical Utilities	2,000
Sales Tax—5%	36,181
Casualty Insurance—1%/year	7,236
Training and installation support (5 man-years @$15,000/m-y, plus 25% fringe)	93,750
Supplies	10,000
Industrial Engineering (1 man-year @$25,000/m-y, plus 25% fringe)	31,250

Next, it is necessary to consider operating costs in years two through seven. "Equipment maintenance cost" will be used as shown. In addition, using the Table 9-1 checklist, the following operating costs for the second year will be projected. These will be inflated at 6% per year for years three through seven.

System Coordinator (data table maintenance), (1 man-year @$20,000/m-y, plus 25% fringe)	$ 25,000
Electrical Utilities	2,000
Casualty Insurance—1%/year	7,236
Training (included in hospital training staff duties without staff addition)	—0—
Supplies	10,000
Industrial Engineering (½ man-year @$25,000/m-y, plus 25% fringe)	15,625

The next step is to examine projected savings. The first adjustment will be to exclude all savings in the first year as savings cannot logically accrue until installation and benefit realization are complete.

Figure 9-1 Cost justification analysis

	Year one	Year two	Year three	Year four	Year five	Year six	Year seven	Total
Software and Hardware	$ 163,620	$ 163,620	$ 163,620	$ 163,620	$ 163,620	$ 163,620	$ 163,620	$1,145,340
Installation Costs	9,729	9,729	9,729	9,729	9,729	9,729	9,729	68,103
Equipment Maintenance [1]	31,332	33,212	35,204	37,316	39,554	41,927	44,442	262,987
TOTAL COSTS	$ 204,681	$ 206,561	$ 208,553	$ 210,665	$ 212,903	$ 215,276	$ 217,791	$1,476,430
Recovery of Lost Charges [2]	$ 109,000	$ 119,900	$ 131,890	$ 145,079	$ 159,586	$ 175,545	$ 193,100	$1,034,100
Reduction of Waste Meals [3]	13,000	14,170	15,445	16,835	18,350	20,001	21,801	119,602
Forms Cost Reduction [4]	9,900	10,890	11,979	13,177	14,495	15,944	17,538	93,923
Discount	6,000	6,000	6,000	6,000	6,000	6,000	6,000	42,000
Reduction of EDP Equip. [5]	2,600	2,600	2,600	2,600	2,600	2,600	2,600	2,600
Increased Cash Flow [6]	20,000	21,800	23,762	25,900	28,231	30,772	33,541	184,006
Personnel Savings [7]	75,000	81,000	87,480	94,478	102,036	110,198	119,014	669,206
TOTAL SAVINGS	$ 235,500	$ 256,360	$ 279,156	$ 304,069	$ 331,298	$ 361,060	$ 393,594	$2,161,037
Total Cost Less Savings	($ 30,819)	($ 49,799)	($ 70,603)	($ 93,404)	($ 118,395)	($ 145,784)	($ 175,803)	($ 684,607)
Cost Per Patient Day	—0—	—0—	—0—	—0—	—0—	—0—	—0—	—0—

NOTES

1—Equipment Maintenance is the only variable cost to the system during the seven year contract. The increase is tied to the Consumer Price Index and for the purpose of this comparison is averaged to a 6% per year increase.

2—Recovery of lost charges is based on a conservative 2.5% of ancillary charges with a 10% per year increase. Using national averages of 3-5% for lost charges would result in significantly more savings than those reflected above.

3—Reduction to wasted meal savings represents a projected 9 meals per day at $3.75 each which are currently lost due to transfers, surgery, diet changes, etc. Those will be eliminated as a result of the instant patient diet status communications. An annual increase of 9% was projected.

4—Form costs have averaged and can reasonably be expected to continue to average a 10% increase for the next seven years.

5—This reflects the elimination of the census system which presently costs $.68 per patient day.

6—The system will result in the patient bill being generated four days sooner than is now possible. This will result in an annual cash flow increase of $222,000, invested at 9% per year.

7—Personnel savings represent 8 FTEs with fringe benefits.

Next, savings from "Recovery of Lost Charges" are deleted based on the reasoning presented earlier in Chapter 3.

All other projected savings are accepted as presented. While an independent reviewer makes somewhat different estimates, the results would not change materially. It is constructive, however, to examine the "Personnel Savings." Elsewhere in the application these are identified as:

Department	*F.T.E. Personnel Reductions*
Admitting	2
E.D.P.	2.5
O.P. Registration	1
Radiology	0.5
Total Reductions	6 F.T.E.

54

These appear quite reasonable for the system proposed. Reductions in admitting and registration may be expected. The radiology reduction undoubtedly is related to more efficient handling of outpatients. The E.D.P. reduction presumably reflects a reduction in key punch operators since charge collection is now automatic and undoubtedly relates to "reduction of E.D.P. equipment" which are probably key punch machines.

Fractional F.T.E. savings are questionable but the assumption will be made that part-time people are being removed from the payroll. Ordinarily, fractional F.T.E. savings are not realizable.

Note that there are no savings in Nursing. Since nursing is by far the largest department in any hospital, typically representing half or more of the work force, major productivity improvement must include major nursing department staff reductions. This is possible only with more comprehensive systems. While no employee data is presented, the subject hospital probably has a work force of one thousand or more. Thus, the productivity impact appears to be less than 1%.

Review of the Benefits Checklist presented in Table 9-2 suggests that all relevant savings were claimed. It is now possible to adjust the Cost Justification Analysis presented in Figure 9-1. The adjusted Cost Justification Analysis is presented in Figure 9-2.

This adjusted analysis suggests a quite different situation than the unadjusted analysis. Ignoring financing costs, it may be seen that the initial investment of $1,038,405 is not recovered over the seven year useful life but is only reduced to $644,259. Thus, the project has a negative return; that is, it costs more than it saves. Therefore, a review decision must be made on the basis of whether the non-financial benefits (e.g., patient care benefits) are worth the increased cost.

To establish this cost, we must calculate the net present value (or cost) using an interest rate approximating the hospital's weighted average cost of capital. It was estimated that the hospital had access to bank credit at 11% and long term lease credit at 13%. Therefore, a reasonable figure for the hospital's weighted average cost of capital is 12%.

Using a financial calculator, the net present cost of this project is calculated to be $804,234. (This calculation discounts the stream of costs or savings back to the present at the chosen interest rate.) The hospital board and the HSA must thus decide if the patient care benefits are worth approximately $800,000.

This example illustrates how an apparently cost-effective project may not be cost-effective at all. Of course, the estimates made here may be open to debate. Nevertheless, this methodology may prove to be useful to those who must make real decisions.

Risk was not considered in our example. The proposed system is a widely installed system from a reputable vendor. Therefore, it is unlikely that results will differ significantly from our adjusted analysis. The major risk is likely to be failure to realize the 6.0 F.T.E. personnel reduction which accounts for a majority of the projected saving. Therefore, as part of a review of this project, a written commitment by the cognizant department managers and the administrator to eliminate the targeted positions on a stated schedule should be required.

In examining a less proven system, it would be necessary to examine the effect of, say, a one year slip. Installation labor costs would continue for year two and savings would not commence until year three. Using the figures from this example, one would conclude the "downside" was perhaps a quarter of a million dollars associated with a one-year schedule slip.

Replacing Ineffective Systems

The method suggested above requires comparison of costs and savings projected for a proposed new system with hospital costs prior to its installation. There is one circumstance where this method may

Figure 9-2 Cost justification analyses—adjusted

	Year one	Year two	Year three	Year four	Year five	Year six	Year seven
Costs							
"Software and Hardware"	$723,628	—	—	—	—	—	—
"Installation Costs"	40,028	—	—	—	—	—	—
"Equipment Maintenance"	31,332	$33,212	$35,204	$37,316	$39,554	$41,927	$44,442
Equipment Shipping	1,500	—	—	—	—	—	—
Site Preparation	12,000	—	—	—	—	—	—
Electrical	5,000	—	—	—	—	—	—
Cabling	7,000	—	—	—	—	—	—
Applications Development	37,500	25,000	26,500	27,825	29,495	31,264	33,140
Electric Utilities	2,000	2,000	2,120	2,247	2,382	2,525	2,676
Sales Tax	36,181	—	—	—	—	—	—
Casualty Insurance	7,236	7,236	7,236	7,236	7,236	7,236	7,236
Training and Install Support	93,758	—	—	—	—	—	—
Supplies—forms	10,000	10,000	11,000	12,100	13,310	14,641	16,105
Industrial Engineering	31,250	15,625	16,563	17,556	18,610	19,726	20,910
Total Costs	$1,038,405	$ 93,073	$ 96,623	$ 104,280	$ 110,587	$ 117,319	$ 124,509
Cumulative Cost	$1,038,405	$1,131,478	$1,230,101	$1,334,381	$1,444,968	$1,562,287	$1,686,796
Savings							
"Recovery of Lost Charges"	—	—	—	—	—	—	—
"Reduction of Waste Meals"	—	$14,170	$15,545	$16,835	$18,350	$20,001	$21,801
"Forms Cost Reduction"	—	10,890	11,979	13,177	14,495	15,944	17,538
"Discount"	—	6,000	6,000	6,000	6,000	6,000	6,000
"Reduction of EDP Equipment"	—	2,600	2,600	2,600	2,600	2,600	2,600
"Increased Cash Flow"	—	21,800	23,762	25,900	28,231	30,772	33,541
"Personnel Savings"	—	81,000	87,480	94,478	102,036	110,198	119,014
Total Savings	—0—	$136,460	$147,366	$158,990	$171,712	$185,515	$200,494
Cumulative Savings	—0—	$136,460	$283,826	$442,816	$614,528	$800,043	$1,000,537
Total Costs Less Savings	$1,038,405	($43,387)	($50,743)	($54,710)	($61,125)	($68,196)	($75,985)
Cumulative Cost Less Savings	$1,038,405	$955,018	$904,275	$849,565	$788,440	$720,244	$644,259

Cost and savings in quotation marks are items contained in the original analysis (Figure 9-1). The other costs and savings items are added as described in the text.

lead to an erroneous conclusion—where the proposed system will replace a previously installed, ineffective system.

To illustrate, consider the extreme case where a hospital has installed a system costing $1 million per year and producing no benefits. The hospital now prepares to replace that system with a new system costing $500,000 per year and producing no benefits. Using the suggested methodology blindly will lead to the result that the new system will save $500,000, and hence, is cost effective. Common sense suggests that an even better plan would be to throw out the old system and reject the new one—and save $1 million!

If circumstances are encountered where this problem may be present, it can be easily avoided by a second economic analysis using the hospital *without* the existing medical information system as the baseline for comparison with the proposed new system.

Partial systems

Occasionally, the reviewer must consider an application to review replacement of a portion of a system or addition to an existing system rather than a totally new system. The procedure is identical to that which we have used for a complete system.

Keep in mind, however, that *marginal* costs and *marginal* savings should be used; that is, only the *changes* in costs and savings. These marginal costs and savings are then related by a return on investment or net present value analysis.

It is possible, of course, that the original system was never subjected to CON review. Apart from the legal prohibition against ex post facto administration of the law, there is little point in reviewing a decision already made and implemented. Instead, attention should be focused on additions, replacement or removal decisions.

Concluding note

The analyst must remind himself that he is attempting to estimate future results. Despite use of six or seven significant figure numbers and sophisticated analytical techniques and calculations, the precision of the analyst's results are still largely limited by the validity of estimates and assumptions.

The real issue before the analyst is whether the project is going to reduce or increase health care costs for the community. If they will increase, some estimate must be made of how much, which can then be related to the nonfinancial benefits. In the case study, it was concluded that the decision makers must decide if the patient care benefits over seven years are worth $800,000 to the community. Failure to focus on this central question often results in the analysis being ignored when the decision is made.

Special Requirements—Research

CHAPTER 10

Introduction

In Chapter 2, it was noted that one of the criteria established by HEW regulations under P.L. 93-641, provides for:

> "The special needs and circumstances of biomedical and behavioral research projects which are designed to meet a national need."

Computer systems have become a widely employed tool in research. Hence, it is desirable to develop some additional tests permitting differentiation between systems properly subject to HSA review based on community needs and standards, and those falling within the criteria cited above.

Materiality

Clearly, the computer systems used solely for research with no application to patient care fall within the "special needs and circumstance." The converse would not fall in this category. Frequently, however, a medical information system may be used for both purposes, particularly in teaching hospitals.

In this case, inquiry must be made into the primary use or motivation for installing the system. If, for example, the system would be discontinued if the research was terminated, it is likely that patient care rendered via the system is incidential and hence not material. Again, the converse is true.

Financial support

If the financial cost of acquisition and operation of a computer system is funded under a research grant or contract, it clearly falls under the "special needs and circumstance" criteria. Here, the converse is less clear. Traditionally, patient care funds have subsidized research to some extent in teaching hospitals. The HSA will be called upon to make a judgment balancing community health care costs against national needs.

Marginal costs

Since systems with mixed objectives (i.e., both patient care *and* research) are likely to present the most difficulty to the reviewer; it may be useful to use marginal analysis. This requires conceptually dividing the proposed system between its objectives. An estimate might be made of the cost of the system and resulting benefits if only the patient care features were provided. This could then be assessed using the HSA's existing community standards. The marginal cost of the research features could then be assessed against the "national need" criteria.

Organizational control

While there is nothing fundamental about which organizational entity controls a computer system, control may sometimes be a useful empirical guideline. It would be reasonable to expect a predominantly research system to be under the control of a medical school or a research investigator. Patient care systems, conversely, would usually be under the control of the hospital administrator or one of the hospital department heads.

This test can, of course, be easily circumvented by simply setting forth the "right answer" in an application. Therefore, it should be viewed as only a helpful adjunct to other tests.

Incremental development

Occasionally, a research-justified computer system will be used as the foundation for subsequent incremental development of a patient care system. Initial

review is avoided and subsequent development proceeds by adding equipment and personnel in increments small enough to fall under the minimum dollar criteria of the HSA. The result may be a system requiring an annual expenditure of a million dollars or more charged against patient care funds and yet no board or HSA review has taken place.

Such a result may reflect the unplanned consequence of opening the Pandora's Box of "do-it-yourself" medical information systems development. Or it may reflect "gamemanship" designed to circumvent both internal and external procedures for major capital expenditures review. Hospital boards and HSAs should maintain sufficient surveillance to assure that incremental development without adequate review is discouraged.

Concluding note

The subject of this book has been a critical review of Certificate-of-Need applications for medical information systems. Shortcomings have been identified and attacked. Decision making by hospitals has been questioned in certain instances.

It is imperative that this critical context not leave the reader, particularly the HSA reviewer, with a negative impression of the merits of medical information systems in the hospital. The opposite is intended and desired. In Chapter 1, the view was expressed that, "both experience and research have amply demonstrated that this technology can have a favorable impact on the quality and cost of hospital-based health care delivery."

Therefore, it is hoped that this book will not be used to block the introduction of this technology, but rather as an aid to permit the health planning review community and the hospital management community to work together toward better, more insightful decisions that will contribute to better, cheaper health care for all.

Appendix
For further reading

This book has been written for the reader who does not have training or experience with medical information systems, yet must make informed decisions on their proposed installation in a hospital. The interested reader may wish to explore this subject further, or may be called upon to direct others to additional sources.

The lay reader may find four publications to be of particular interest:

Austin, Charles: "Information Systems for Hospital Administration," Health Administration Press, 1979.

Hodge, Melville H.: "Medical Information Systems," Aspen, Germantown, Maryland, 1977.

Lindberg, Donald: "The Growth of Medical Information Systems in the United States," Lexington Book, 1979.

Office of Technology Assessment: "Policy Implications of Medical Information Systems," Congress of the United States, Washington, D.C., November, 1977.

The most extensive evaluation of patient care and economic benefits from a medical information system ever carried out was that conducted by the Battelle Columbus Laboratories under HEW sponsorship of the Technicon Medical Information System installed at the El Camino Hospital, Mountain View, California. The research findings are contained in a series of reports:

Barrett, James P., Barnum, Ronald A., Gordan, Benjamin B., and Pesut, Robert N.: "Final Report on Evaluation of a Medical Information System in a General Community Hospital," Battelle Columbus Laboratories, Columbus, Ohio, December 19, 1975.

Gall, John E., Jr., Norwood, Donald D., Cook, Margo, Fleming, John C., Rydell, Richard & Watson, Ralph J.: "Demonstration and Evaluation of a Total Hospital Information System," El Camino Hospital, Mountain View, California, December 1975.

Barrett, James P., Hersch, Phillip L., and Caswell, Ralph J.: "Executive Summary on Evaluation of the Impact of the Implementation of the Technicon Medical Information System at El Camino Hospital—Part II—Economic Trends Analysis," Battelle Columbus Laboratories, Columbus, Ohio, May 14, 1979.

An excellent summary of the cost-effectiveness aspects of the El Camino experience has been published by an NCHSR author:

Coffee, Rosanna M.: "How a Medical Information System Affects Hospital Costs: The El Camino Hospital Experience," National Center for Health Service Research, DHEW Publication No. (PHS) 80-3265, March 1980.

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A useful review of research in this field is contained in:

Medical Information Systems Cluster, Division of Extramural Research: "Computer Applications in Health Care," National Center for Health Services Research, U.S. Department of Health, Education, and Welfare, June 1979.

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